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Introduction

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Scientific and technical reports of the National Aeronautics and Space Administration and its contractors; scientific and technical reports of government agencies, universities, and research organizations throughout the world.

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By arrangement between NASA and the American Institute of Aeronautics and Astronautics, the AIAA publication *International Aerospace Abstracts* is issued in coordination with *STAR*. Each journal appears on alternate weeks. *IAA* uses subject categories identical with those in *STAR*, and publishes similar indexes. *IAA's* worldwide coverage of books and scientific and trade journals complements *STAR's* worldwide report coverage. The two publications thus provide comprehensive access to current literature on aerospace science and technology.

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INDEXING VOCABULARY

The Preliminary Edition of the *NASA Thesaurus* (December 1967) (NASA SP-7030) is being used as the authority for the indexing vocabulary that appears in the subject index to this issue. The terminology has been modified from the *Guide to the Subject Indexes for STAR* (NASA SP-7016), the authority used for the vocabulary to indexes published prior to 1968. The *NASA Thesaurus* should be consulted for a total picture of the current indexing vocabulary including associated cross reference structure. Only the subject terms that have been selected to describe the documents abstracted in this issue appear in the subject index. Copies of the *NASA Thesaurus* may be obtained from the Clearinghouse for Federal Scientific and Technical Information or the U. S. Government Printing Office at a price of $8.50 for the three-volume set.

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Includes fixed-wing airplanes, helicopters, gliders, balloons, ornithopters, etc; and specific types of complete aircraft (e.g., ground effect machines, STOL, and VTOL); flight tests; operating problems (e.g., sonic boom); safety and safety devices; economics; and stability and control. For basic research see: 01 Aerodynamics. For related information see also: 31 Space Vehicles; and 32 Structural Mechanics. **1269**

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Includes communications equipment and techniques; noise; radio and communications blackout; modulation telemetry; tracking radar and optical observation; and wave propagation. For basic research see: 23 Physics, General; and 21 Navigation. **1300**

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Includes electronic test equipment and maintainability; component parts, e.g., electron tubes, tunnel diodes, transistors; integrated circuitry; microminiaturization. For basic research see: 10 Electronics. For related information see also: 07 Communications and 21 Navigation. 1312

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Includes boundary-layer flow; compressible flow; gas dynamics; hydrodynamics; and turbulence. For related information see also: 01 Aerodynamics; and 33 Thermodynamics and Combustion. 1324

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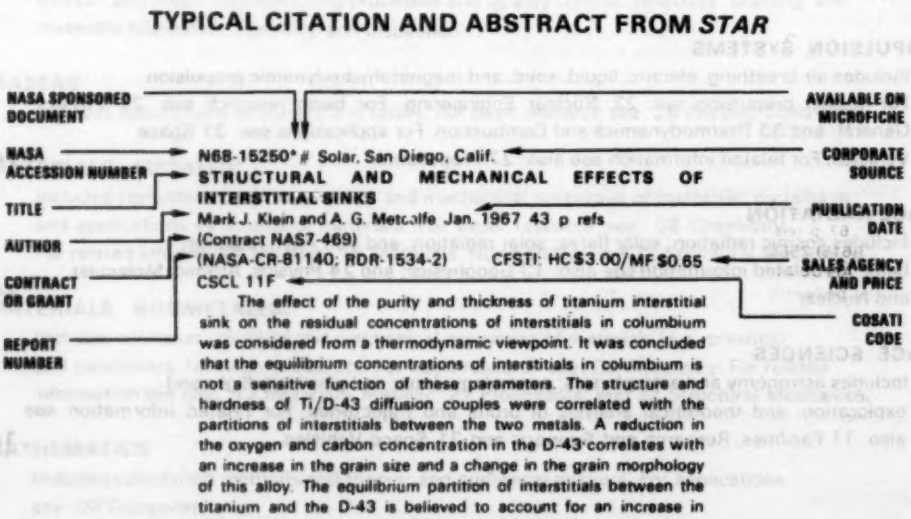
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The effect of the purity and thickness of titanium interstitial sink on the residual concentrations of interstitials in columbium was considered from a thermodynamic viewpoint. It was concluded that the equilibrium concentrations of interstitials in columbium is not a sensitive function of these parameters. The structure and hardness of Ti/D-43 diffusion couples were correlated with the partitions of interstitials between the two metals. A reduction in the oxygen and carbon concentration in the D-43 correlates with an increase in the grain size and a change in the grain morphology of this alloy. The equilibrium partition of interstitials between the titanium and the D-43 is believed to account for an increase in the hardness of the titanium, but this partition does not seem to affect the hardness of the D-43.
Author

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Scientific and Technical Aerospace Reports

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01 AERODYNAMICS

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N68-18281# Rutgers Univ., New Brunswick, N. J. Dept. of Mechanical and Aerospace Engineering.

SECOND-ORDER THEORY FOR FLOW PAST OSCILLATING FOILS Final Technical Report, Feb. 1966–May 1967

Chuan F. Chen and Richard A. Wirtz Aug. 1967 45 p refs

(Contract Nonr-404(22))

(TR-116-ME-F; AD-664262)

A second-order theory for the lifting problem was developed for foils performing harmonic oscillations either in plunging or pitching modes. The second-order problem is obtained by systematic expansions of the variables involved. By a suitable definition of the second-order acceleration potential, the second-order problem is reduced to a form similar to that of the first-order problem. The method used for the first-order problem was applied for the solution of the second-order problem with some modifications. Numerical results were obtained for a symmetric Joukowsky foil oscillating in plunging or pitching mode. These results are compared with existing results on the effect of finite thickness of the foil, and to some recent results obtained by numerically solving the full nonlinear problem. Author (TAB)

N68-18330# General Applied Science Labs., Inc., Westbury, N. Y.

THEORETICAL STUDIES OF CONFIGURATIONS HAVING HIGH LIFT-TO-DRAG RATIOS IN THE VISCOUS INTERACTION REGIME Final Report, Apr. 1964–Apr. 1967

Gianky Da Forno Wright-Patterson AFB, Ohio AF Flight Dyn. Lab. Dec. 1967 67 p refs

(Contract AF 33(615)-2568)

(GASL-TR-647; AFFDL-TR-67-50; AD-664047)

Work was performed to organize theoretical methods for studying aerodynamic components to obtain configurations having high lift to drag ratios in the 150 to 250 Kft altitude range. The main part of the work was devoted to preparing the computational tools needed to develop a two-dimensional wing profile using an inverse approach, i.e., evolving the profile from the desired pressure distribution. Since approximate engineering methods were found insufficient, three computer programs were developed or adapted. They are: two inverse characteristics programs, one with and one without imbedded shocks; a boundary layer program suited to hypersonic, near separation situations; and an accurate blunt body program. With these tools, it is possible to predict the whole flow field, inviscid and viscous, over the nose (in a direct manner) and over the rest of the profile (in an inverse manner). Various difficulties encountered in developing these tools are reported in detail. The other part of the work was an analytical study of the flow at junction of a wing and a fin. Author (TAB)

N68-18338# Rutgers Univ., New Brunswick, N. J. Dept. of Mechanical and Aerospace Engineering.

SECOND-ORDER THEORY FOR AIRFOILS IN NONUNIFORM SHEAR FLOW

C. F. Chen and R. J. Wright Nov. 1967 41 p refs

(Contract DA-31-124-ARO(D)-387)

(TR-117-ME-F; AROD-5609.3-E; AD-664182)

A second-order theory was developed for airfoils in nonuniform shear flow. It is assumed that both the nonuniform vorticity in the approaching stream and the disturbances caused by the airfoil are of the same small order of magnitude. The first-order stream function satisfies Laplaces equation, which can be solved by known methods. The second-order stream function satisfies Poissons equation, which was solved by using the Greens function. Expressions for lift and moment coefficients were obtained for a symmetric Joukowski airfoil in a nonuniformly sheared flow whose velocity profile may be represented by a third-order polynomial. Numerical values of lift and moment coefficients were obtained for parabolic flow past a Joukowski airfoil. TAB

N68-18440# Princeton Univ., N. J. Gas Dynamics Lab.

EXPERIMENTAL STUDIES OF A LAMINAR HYPERSONIC CONE WAKE

Earll M. Murman Nov. 1967 71 p refs

(Contracts Nonr-1858(37); F33615-67-C-1065)

(Rept.-806; AD-664253)

An experiment was conducted which is representative of the wake flow for a hypersonic Mach number-low Reynolds number flight condition. A 10 degree half-angle sharp cone was magnetically suspended in a Mach sixteen helium stream. A conventional hypersonic wind tunnel of long test duration generated the flow and provided the basis for an experiment which was purely fluid mechanical in nature. The cone model was at the adiabatic wall temperature and zero angle of attach. The free stream Reynolds number based on the one inch cone base diameter was 121,000. The base pressure was higher than the freestream ambient level. There was no appreciable extent of constant axial static pressure in the base flow region. A maximum axial static pressure (freestream conditions) of 2.4 was found at Z = 0.75 D. Downstream of this, the static pressure decreased to near freestream level at about Z = 5D. A rapid acceleration of the axial flow in the near wake was observed downstream of the wake stagnation point. At Z = 5D, the axial velocity returned to about 70-80% of the freestream value. The trailing shock wave origin is near Z = 1D, and it emerges from the viscous wake around Z = 3D. The spatial extent of the recirculation region, recompression zone, wake thickness, and overall near wake region were on the order of the model base diameter. Author (TAB)

N68-18471# Purdue Univ., Lafayette, Ind. Fluid Mechanics Group.

SUBSONIC FLOW IN CONICAL DIFFUSERS Final Report, 23 Jun. 1963–31 Aug. 1967

Robert W. Fox Sep. 1967 25 p

(Contract DA-31-124-ARO(D)-138)

(FMTR-67-1; AROD-4332-6-E; AD-664185)

The report presents a brief summary of an experimental investigation of subsonic flow in conical diffusers. Following a brief statement of the problem, the major results and conclusions are presented. Since all of the technical material was reported in previous publications, a listing of these publications is presented. All diffuser performance data taken during the course of the investigation are tabulated in the appendices. Author (TAB)

N68-18643# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

SMALL PARAMETER METHOD FOR HYPERSONIC IDEAL GAS FLOW AROUND POINTED BODIES [METOD MALOGO PARAMETRA PRI OBTEKANII OSTRONOSYKH TEL GIPERZVUKOVYM POTOKOM IDEAL'NOGO GAZA]

G. Bush *In its* Herald of Leningrad Univ., Math., Mech. and Astronomy Ser., No. 1, 1963 27 Apr. 1967 p 107–111 refs (See N68-18631 09-19)

The small-parameter method is known to have a singularity at the point with zero contour pressure. A method is given in which this singularity is absent for pointed plane and axially symmetric bodies with continuous curvature. The results of the analysis are applied to the gas flow around a thin parabolic airfoil. Author

N68-18682# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

CAMBER BALANCING OF A DELTA WING AT HYPERSONIC VELOCITIES [BALANSIROVKA TREUGOL'NOGO KRYLA PRI GIPERZVUKOVYKH SKOROSTYAKH KRIVIZNOY]

Ye. V. Bulygina *In its* News of Inst. of Higher Learning. Aeron. Eng. 10 Apr. 1967 p 125–128 refs (See N68-18668 09-23)

The balancing mechanism of a tailless flying device was studied analytically. A delta-wing is considered at a small angle of attack where Newtonian flow is valid at hypersonic speeds. The problem consists of finding a surface which, when balanced, has the minimum resistance for a given volume. The solution is obtained by using the Lagrange method. Expressions are determined for the aerodynamic coefficients as functions of the curvature. The center of pressure is determined, and the condition for stability is obtained by setting the center of gravity equal to the center of pressure. Author

N68-18688# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THE INFLUENCE OF AN ATTACHED VOLUME ON THE SPEED OF ROTATION OF A STALL ZONE [VLIYANIYE PRISOYEDINENNOGO OB"YEMA NA SKORST' VRASHCHENIYA SRYVNOY ZONY]

N. I. Sapozhnikov *In its* News of Inst. of Higher Learning. Aeron. Eng. 10 Apr. 1967 p 161–165 refs (See N68-18668 09-23)

The effect of a circular closed volume attached to the separation zone of a multistage compressor on the rotation speed of the separated zone was studied. It is assumed that the gas density, the angular width, and the height of the separation zone remain constant. From mass and momentum conservation considerations, an expression is derived for the rotation speed. Author

N68-18720*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

COMPARISON OF THE MACH 3.0 AERODYNAMIC CHARACTERISTICS OF TENSION STRING, TENSION SHELL, AND 120° CONICAL SHAPES

James Wayne Sawyer Washington Mar. 1968 30 p refs

(NASA-TN-D-4360) CFSTI: HC $3.00/MF $0.65 CSCL 01A

An investigation was conducted at a Mach number of 3.0 to determine aerodynamic characteristics of three decelerator shapes based on the tension string structural concept. The shapes were tested at angles of attack up to 12° and at free-stream Reynolds numbers, based on maximum body diameter, of approximately 1.0×10^6 and 3.0×10^6. A comparison was made between the aerodynamic characteristics thus obtained and published results for a 120° cone and comparable tension shell configurations. The results showed that the tension string shapes were more susceptible to flow separation than the tension shell shapes, but the aerodynamic coefficients of the tension string shapes were not affected by the onset of flow separation as much as were the aerodynamic characteristics of the tension shell shapes. The aerodynamic coefficients, static stability, and aerodynamic centers of the tension string shapes showed little sensitivity to variation in body length and nose radius and, in general, approximated those of the cone. Author

N68-18765*# Lockheed Missiles and Space Co., Huntsville, Research and Engineering Center.

AERODYNAMIC CHARACTERISTICS FOR CONE-CYLINDER-FRUSTUM-CYLINDER CONFIGURATIONS AT MACH NUMBERS FROM 0.7 TO 1.96. VOLUME 1: LINEAR LOAD DISTRIBUTIONS

J. F. Thompson 23 Nov. 1966 156 p refs

(Contract NAS8-20121)

(NASA-CR-61626; LMSC/HREC-A783468, V. 1; HREC-2012-1, V. 1) CFSTI: HC $3.00/MF $0.65 CSCL 01A

The data from an extensive wind tunnel pressure distribution test program were analyzed to provide linear aerodynamic load distributions in the high subsonic, transonic and low supersonic Mach number regimes for cone-cylinder-frustum-cylinder configurations. The geometrical parameters varied in this study were the cone semivertex angles (from 15° to 40°); the conical frustum angles (from 7.5° to 20°); cylinder diameter ratios (D_2/D_4 = 0.4, 0.6, 0.8); and the forward cylinder lengths (from 0.5 to 4.0 calibers). The aft cylinder lengths were constant at 3.5 calibers. A comprehensive set of design curves is presented which will enable the designer to determine aerodynamic loads in a Mach number range where adequate information has not been available. Local normal force slope distributions for the segments of a cone-cylinder-frustum-cylinder were developed on a parametric basis for the area of interest. Force slope distributions for the nose cone have been determined in the previous cone-cylinder study and are not presented here. The loads presented here are the distributed loads on the other three sections of the cone-cylinder-frustum-cylinder configuration: forward cylinder, frustum and aft cylinder. Author

N68-18815*# National Aeronautics and Space Administration, Washington, D. C.

RECENT DEVELOPMENTS IN WIND TUNNEL MEASUREMENTS OF AERODYNAMIC DERIVATIVES [PROGRES REALISES DANS LES TECHNIQUES DE MESURE DES DERIVEES AERODYNAMIQUES EN SOUFFLERIE METHODE D'OSCILLATIONS FORCEES]

M. Scherer and J. Lopez Mar. 1968 33 p refs Transl. into ENGLISH from ONERA-TP-389

(NASA-TT-F-11510; ONERA-TP-389) CFSTI: HC $3.00/MF $0.65 CSCL 01A

Some of the most important unsteady-testing devices used in wind-tunnels are presented. These devices give the complete set of derivatives, the knowledge of which is necessary to the study of flight mechanics of planes or missiles. The tests can be carried out in continuous or in intermittent wind-tunnels. Sting dynamometers and microaccelerometers equipped with silicium strain-gages are now employed. An example is given for comparison of the

wind-tunnel measurements; it deals with the measurement in flight and in wind-tunnel of the STOL-Breguet 941 in landing configuration. Author

N68-18830*# Rice Univ., Houston, Tex. Dept. of Mechanical and Aerospace Engineering and Materials Science.
CONICAL BODIES OF GIVEN LENGTH AND VOLUME HAVING MAXIMUM LIFT-TO-DRAG RATIO AT HYPERSONIC SPEEDS: DIRECT METHODS
Angelo Miele, John C. Heideman, and Robert E. Pritchard 50 p refs
(Grant NGR-44-006-063)
(NASA-CR-66572; AAR-34) CFSTI: HC $3.00/MF $0.65 CSCL 01A

A study of the lift to drag ratios attainable by a slender, conical body flying at hypersonic speeds is presented under the assumptions that the pressure distribution is modified Newtonian and the surface averaged friction coefficient is constant. Focused on are configurations whose length and volume are given, while the cross sectional elongation ratio is free. The longitudinal contour is assumed conical for all cases studied. Several two parameter and three parameter families of transversal contours were studied. Comparative data on the effects of flat top shapes, flat bottom shapes, shapes locally optimum aerodynamically, and diamond and lenticular shapes, on lift to drag ratios are given. S.C.W.

N68-19022*# Techtran Corp., Glen Burnie, Md.
FUNDAMENTALS OF THE AERODYNAMICS OF HYPERSONIC VELOCITIES [OSNOVY AERODINAMIKI GIPERZVUKOVYKH SKOROSTEY]
N. S. Arzhanikov and G. S. Sadekova Washington NASA Mar. 1968 59 p Transl. into ENGLISH from the book "Aerodinamika Bol'shikh Skorostey" Moscow, Izd. Vysshaya Shkola, 1965 p 348–409
(Contract NASw-1695)
(NASA-TT-F-11457) CFSTI: HC $3.00/MF $0.65 CSCL 01A

Hypersonic flow is evaluated extensively in terms of its inherent differences as opposed to the characteristics of moderate supersonic flow. The differing behaviors of gas particles under the two conditions are discussed. The interaction between the shock wave and the boundary layer is explained. Thermodynamic balance and both dissociation and association of the gas molecules are gone into in detail. Hypersonic flow is discussed at an obtuse angle greater than 180°. The aerodynamic characteristics of a plane plate in hypersonic flow are determined. Pressure distribution over a body surface is determined by local wedges (cones). Flow around a blunt body is also examined in terms of detached compression shocks. Flow parameters behind a compression shock are determined. Author

N68-19023*# Techtran Corp., Glen Burnie, Md.
FUNDAMENTALS IN THE THEORY OF A WING PROFILE IN A SUPERSONIC FLOW [OSNOVY TEORII PROFILYA KRYLA V SVERKHZVUKOVOM POTOKE]
N. S. Arzhanikov and G. S. Sadekova Washington NASA Mar. 1968 29 p Transl. into ENGLISH from the book "Aerodinamika Bol'shikh Skorostey" Moscow, Izd. Vysshaya Shkola, 1965 p 176–205
(Contract NASw-1695)
(NASA-TT-F-11456) CFSTI: HC $3.00/MF $0.65 CSCL 01A

Velocity components are found for turbulence in supersonic flow at various Mach angles. Linear flow at obtuse angles close to 180° is stressed. Supersonic flow is studied around a plane plate. Flow conditions are considered which result in compression or rarefaction. Differences are noted in pressure distribution and lift along a plate in sub- and supersonic flow. Flow is compared in viscous and inviscid gases. Supersonic flow is examined around a thin profile with a sharp edge with respect to compression lines and rarefaction lines. Stress-strain diagrams are constructed for pressure distribution. The applicability of linear theory to a thin profile in subsonic flow is evaluated. Author

N68-19024*# Techtran Corp., Glen Burnie, Md.
THEORY OF A WING WITH FINITE SPAN IN SUPERSONIC FLOW [TEORIYA KRYLA KONECHNOGO RAZMAKHA V SVERKHZVUKOVOM POTOKE]
N. S. Arzhanikov and G. S. Sadekova Washington NASA Mar. 1968 71 p Transl. into ENGLISH from the book "Aerodinamika Bol'shikh Skorostey" Moscow, Izd. Vysshaya Shkola, 1965 p 206–280
(Contract NASw-1695)
(NASA-TT-F-11461) CFSTI: HC $3.00/MF $0.65 CSCL 01A

Supersonic flow around a wing with finite span is analyzed for a wing of arbitrary planform with and without supersonic flow at the tip. The delta-wing is also analyzed, and rectangular wing and wave resistances are determined. Author

N68-19058# Royal Aircraft Establishment, Farnborough (England).
THREE-FRONT CONFIGURATIONS WITH ENERGY ADDITION
Dietrich Rues Nov. 1967 26 p refs Transl. into ENGLISH from German Report Presented at the 3d Euromech. Symp., Aachen, 1966
(RAE-LIB-TRANS-1260) CFSTI: HC $3.00/MF $0.65

Various possibilities concerning the addition of energy at surfaces of discontinuity in a supersonic parallel flow are discussed. It is seen that the supply of energy at a front with simultaneous formation of only one shock wave is not possible, but that, in addition to the energy front, at least two shock fronts must be produced. The different wave angles which may be encountered and the pressures and the streamline angles behind the fronts are calculated for an upstream Mach number $M_\infty = 10$ and a supply of energy $q_i/W_\infty^2 = 0.1$. For certain ranges there are several solutions, whereas, for others, which naturally include the choking range, no steady solutions exist. Author

N68-19063*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EFFECT OF TWO-DIMENSIONAL MULTIPLE SINE-WAVE PROTRUSIONS OF THE PRESSURE AND HEAT-TRANSFER DISTRIBUTIONS FOR A FLAT PLATE AT MACH 6
Aubrey M. Cary, Jr. and E. Leon Morrisette Washington Mar. 1968 57 p refs
(NASA-TN-D-4437) CFSTI: HC $3.00/MF $0.65 CSCL 01A

Surface pressure and heat transfer were measured and oil-flow patterns were observed on two-dimensional, shallow, multiple sine-wave protrusions embedded in a flat surface. The maximum laminar heating on multiple waves was found to correlate empirically with results from previous investigations. The maximum turbulent heating for a series of waves decreased rapidly from wave to wave. Tests with single waves and with the first wave of the multiple-wave model indicated that the maximum turbulent heating on single waves increased almost linearly with decreasing width-height ratio of the wave. The method used to predict the maximum turbulent heating gave fair results when there was no boundary-layer separation prior to the wave. Author

N68-19180*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
ANALOG STUDY OF THE LONGITUDINAL RESPONSE OF A SWEPT-WING TRANSPORT AIRPLANE TO WIND SHEAR AND SUSTAINED GUSTS DURING LANDING APPROACH
C. Thomas Snyder Washington Apr. 1968 20 p refs
(NASA-TN-D-4477) CFSTI: HC $3.00/MF $0.65 CSCL 01B

Analog-computed time histories and altitude-ground track plots indicate the longitudinal responses of the airplane to varying wind conditions. Controls-fixed runs first demonstrated the differences in responses of an airplane to horizontal gusts and to

vertical gusts. Airplane static stability, lift-curve slope, lift-drag ratio, and airplane size were varied while the airplane, with controls fixed, was subjected to wind shear and sustained gusts. Controlled responses showed the effect of maintaining constant pitch attitude or constant airspeed during flight in a wind shear region, into a downdraft, and into a combined wind shear and downdraft. Realistic combinations of downdraft and shear (of decreasing head wind) were found that could significantly steepen descent with little initial attitude change. In fact, the initial changes in attitude and airspeed might induce the pilot to steepen the flight path further. Author

N68-19189*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

LARGE-SCALE WIND-TUNNEL TESTS OF AN AIRPLANE MODEL WITH TWO PROPELLERS AND ROTATING CYLINDER FLAPS

James A. Weiberg and Berl Gamse Washington Mar. 1968 49 p refs

(NASA-TN-D-4489) CFSTI: HC$3.00/MF$0.65 CSCL 01A

Wind-tunnel tests were made of a model of a twin turbo-propeller airplane with rotating cylinder flaps. The model had a straight untapered wing of aspect ratio 3.57 equipped with end plates. Cylinder rotation provided a lift coefficient increment of 2.0 and a maximum lift coefficient of 4.0 with 60° flap deflection and zero propeller thrust. A maximum lift coefficient of 9.1 was obtained with a thrust coefficient of 4. The cylinder rotational speed required varied with flap deflection and was independent of angle of attack and slipstream velocity. For a flap deflection of 60° and a free-stream velocity of 40 knots, the cylinder power required was approximately 0.7 horsepower per foot of cylinder length. Author

N68-19206*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

PRELIMINARY STUDY OF DRAG REDUCTION FOR COASTING MISSILES AT MACH NUMBERS FROM 1.57 TO 4.63

Dennis E. Fuller and Donald L. Wassum Washington Apr. 1968 66 p

(NASA-TM-X-1537) CFSTI: HC$3.00/MF$0.65 CSCL 16D

An investigation of various body alterations aimed at reducing the drag of a missile during power-off flight was made. Tests were made for conical afterbody closures of two lengths (with and without slots), afterbody perforations, and afterbody scoops. The investigation was made at Mach numbers from 1.57 to 4.63, angles of attack from about −4° to 4°, and a Reynolds number of 9.84×10^6 per meter. The results indicated that a conical afterbody closure with a closure-length–body-diameter ratio of about 2.9 effected sizable reductions in drag and increases in lift-drag ratio for the test Mach number range; for the lower test Mach numbers an afterbody closure with a closure-length–body-diameter ratio of about 1.4 provided an increase in drag and a decrease in lift-drag ratio. A reduction in the ratio of a slot area to cone area for the long afterbody closure led to progressive decreases in drag coefficient with corresponding increases in lift-drag ratio. Afterbody perforations provided a means of obtaining moderate drag reductions throughout the test Mach number range. Author

N68-19237*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

EFFECT OF BOATTAIL JUNCTURE SHAPE ON PRESSURE DRAG COEFFICIENTS OF ISOLATED AFTERBODIES

George D. Shrewsbury Washington Mar. 1968 34 p refs

(NASA-TM-X-1517) CFSTI: HC$3.00/MF$0.65 CSCL 01A

A variety of afterbodies were tested on a sting-supported model of a closed-inlet nacelle. Jet effects were simulated with a cylinder positioned downstream of the afterbody base. Axial-force coefficients were obtained for a 7° conical boattail and various 15° boattailed afterbodies on which the boattail juncture with the cylindrical portion of the nacelle had been smoothed with different radii of curvature. Data were obtained over a Mach number range of 0.56 to 1.00 at angles of attack from 0 to 8°. The results indicate that increasing the boattail radius of curvature generally delays the occurrence of the transonic drag rise. Author

N68-19341*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

A METHOD FOR THE SURFACE INSTALLATION AND FAIRING OF STATIC-PRESSURE ORIFICES ON A LARGE SUPERSONIC-CRUISE AIRPLANE

Norman V. Taillon Washington Mar. 1968 12 p

(NASA-TM-X-1530) CFSTI: HC$3.00/MF$0.65 CSCL 01C

A method for installing and fairing static-pressure orifices on the wing surface of a supersonic airplane without penetrating the skin is described. Orifice discs were fixed to pressure tubes which were, in turn, attached to the ferrous skin by welded straps. The assembly was faired over with a temperature-resistant aerodynamic smoothing compound hand-milled flush with the orifices. Some deviation from the mold line is inherent in the method; however, analytical estimates indicate that the effect on local aerodynamic pressures is negligible for this installation. The smoothing compound has been found to be operationally suitable at a Mach number of 3. Author

N68-19350*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

MEASUREMENT OF AERODYNAMIC DERIVATIVES IN WIND TUNNELS AND IN FLIGHT. PART 1: RESEARCH IN WIND TUNNELS. PART 2: DETERMINATION IN FLIGHT OF THE AERODYNAMIC COEFFICIENTS OF AN AIRCRAFT BY THE STUDY OF ITS FREQUENCY RESPONSE

M. Scherer and P. Mathe Redstone Arsenal, Ala. Redstone Sci. Inform. Center 23 Dec. 1967 60 p refs AGARD Fluid Dyn. and Flight Mech. Panels Meeting of Specialists on Stability and Control, Rhode-Saint-Genese, Belgium, 10–14 Apr. 1961 Sponsored jointly by NASA and Army Missile Command

(NASA-TM-X-60930; RSIC-738; AGARD-346) CFSTI: HC $3.00/MF$0.65 CSCL 01A

The discussion covers the current state of techniques for measuring aerodynamic derivatives in wind tunnels and in flight and justifies the extent to which they may be relied on in the domain of sonic and supersonic speeds by comparing the few available results. The first part deals with experimental methods in wind tunnels of moderate dimensions. With the help of the theory, these should furnish, at the preliminary stage, the aerodynamic data necessary for the discussion of stability and maneuvering. However, in spite of the progress recently made in the techniques of calculating or measuring in wind tunnels, numerous problems remain, especially in the transonic domain. The builder is thus led to undertake, a posteriori on the prototype machine, the measurement in flight of the aerodynamic coefficients, with the object of confirming or even completing the results which he was able to obtain in the course of studying the project. The second part of this paper is devoted to this second aspect of the problem. Author

N68-19413# Royal Aircraft Establishment, Farnborough (England).

THE AERODYNAMIC SPIKE FOR DRAG REDUCTION AND RAIN DROP DISINTEGRATION AT LOW SUPERSONIC VELOCITIES

George J. Tatnall *In its* Rain Erosion and Assoc. Phenomena Aug. 1967 p 221–232 ref (See N68-19461 09-13)

Limited wind tunnel aerodynamic spike investigations at low supersonic Mach numbers were made to establish the basic design parameters associated with the use of such devices. When this is accomplished these disintegration devices may be used with a minimum penalty to the vehicle in terms of velocity, range and maneuver performance. Even more important is their integration into a system with a minimum degradation to the system electrical performance. Relatively simple fixed aerodynamic spikes were selected for two typical vehicle nose shapes. Both plain spikes and

cone-spikes were investigated for the effects of spike cone angle, length, Mach number and angle-of-attack. Data is given for spike designs to optimize the forebody drag and is compared with the basic body drag. Schlieren photographs show the development and change of flow patterns over a range of spike lengths. The drop disintegration equation is applied to an optimum cone-spike configuration to show that drop fragmentation will occur on large bodies. Author

02 AIRCRAFT

Includes fixed-wing airplanes, helicopters, gliders, balloons, ornithopters, etc; and specific types of complete aircraft (e.g., ground effect machines, STOL, and VTOL); flight tests; operating problems (e.g., sonic boom); safety and safety devices; economics; and stability and control. For basic research see: 01 Aerodynamics. For related information see also: 31 Space Vehicles; and 32 Structural Mechanics.

N68-18319# Kansas Univ., Lawrence. Engineering Science Div.
BIBLIOGRAPHY OF THE AIR CUSHION VEHICLE TECHNOLOGY WITH A GUIDE FOR DESIGN AND ANALYTIC ENGINEERS
T. Bratanow J Nov. 1967 138 p refs
(Contract Nonr-4201(00))
(AD-664505)

Contents: Hydrodynamics; Aerodynamics; Stability and control; Experimentation; Analysis; Air cushion vehicle research; Surface effect ships; Hydrofoil research; and Submarine research. TAB

N68-18336# RAND Corp., Santa Monica, Calif.
AIR TRANSPORTATION IN THE 1970'S: PROBLEMS AND OPPORTUNITIES
T. F. Cartaino Jan. 1968 38 p
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5268-PR; AD-664040)

An examination is made of the problems, and possible solutions, of commercial air transportation in the 1970s, with emphasis on subsonic passenger vehicles that will be in operation by 1975. Major air transportation problems in the 1970s will be centered in and around the terminal areas. Airport noise and the adverse reactions of adjacent communities are already serious. Economic comparisons of new aircraft types for domestic and international transport are made on the basis of a theoretical fare, i.e., the fare that an airline operator would have to charge to earn a given rate of return on his investment. Possible solutions include establishment of regional air centers away from metropolitan areas; VTOL vehicles for short-haul intercity, city-to-airport, and airport-to-airport transport (50-200 miles); air busses for medium-haul transport (500-2000 miles); the subsonic stretched jet and jumbo jet for domestic long-haul transport (2500 miles). The subsonics are competitive for international long-haul transport up to 4000 miles; the jumbo jet has a 6000-mile full-load range. Technological advances include the supercritical wing; economical methods of using titanium for lighter, safer airframes; and improved safety devices. Author (TAB)

N68-18374# Royal Aircraft Establishment, Farnborough (England).
TYRE WEAR TESTS ON AN OPEN GRADED MACADAM RUNWAY FRICTION COURSE
E. J. Key Aug. 1967 24 p refs
(RAE-TR-67178; AD-664528)

Aircraft trials were made to evaluate tyre wear on the north/south runway at Farnborough, after resurfacing with an open graded macadam friction course. A Meteor Mk.7 aircraft equipped with low pressure tyres was used for the trials, which involved landings on the surface, under dry conditions, with maximum braking applied. For comparison, similar trials were made on the main runway, which had a grooved asphalt wearing course and was used as a reference surface. Thirty five landings were made on each surface. Comparison of wear by two methods, measurement of groove depth, and loss of tyre weight, indicated that the wear was about 8-10% lower on the open graded surface, under the conditions of the test. Author (TAB)

N68-18388# Aerospace Medical Div. Aerospace Medical Research Labs. (6570th), Wright-Patterson AFB, Ohio.
RELIABILITY OF SELECTED HOW-MAL CODE CLUSTERS: B-58 SYSTEM Final Report, Jun.–Aug. 1966
William H. Pearson Sep. 1967 16 p refs
(AMRL-TR-67-196; AD-664071)

The purpose of this study was to identify groups of How-Mal (AFM 66-1) codes which are redundant, i.e., are equivalent within a group. The frequencies of use of the 35 most frequently used How-Mal codes over 4 types of maintenance actions and 203 subassemblies of the B-58 were analyzed statistically. A principal-axis factor analysis revealed 14 groups of codes, 3 of which were found in a previous study. Twenty of the codes accounted for 95% of the 12,041 malfunctions reported. The frequencies of appearance of the codes were correlated $r = 0.76$ with their appearance in an earlier study. Several How-Mal codes are recommended for rejection from the list of allowable codes. Author (TAB)

N68-18467# Dynasciences Corp., Blue Bell, Pa.
FABRICATION AND TESTING OF AN ACTIVE ELECTROSTATIC DISCHARGER SYSTEM FOR THE CH-47 HELICOPTER Final Report, Aug. 1963–Dec. 1966
Juan de la Cierva, David B. Fraser, and Paul B. Wilson, Jr. Oct. 1967 63 p
(Contract DA-44-177-AMC-114(T))
(DCR-224B; USAAVLABS-TR-67-60; AD-664201)

Numerous incidents of severe shock to ground personnel and potential hazards to cargo during external sling load cargo operations have led to extensive research efforts aimed at the dissipation of high electrostatic energy levels present on helicopters. The Model D-03 Electrostatic Discharger is essentially a closed-loop servo system. The report covers its fabrication, mechanical evaluation, environmental testing, and flight testing under both arctic and dusty/high-humidity conditions. Drawings and photographs are included in the report as an aid to a thorough understanding of the system. TAB

N68-18470# Federal Aviation Agency, Oklahoma City, Okla.
FAA DEVELOPMENTS RELATIVE TO DESIGN OF NEW AIRCRAFT SYSTEMS
[1967] 4 p Presented at the FAA Maintenance Symp., Oklahoma City, 9 Nov. 1967
(AD-664386)

The principal FAA developments relative to new aircraft systems are certification techniques for unique requirements, methods of evaluation, reliability analysis, and recognition of the importance of designed-in maintainability to continuing airworthiness and conditional reliability for the life of the system. Author (TAB)

N68-18539# American Airlines, Inc., Tulsa, Okla. Maintenance and Engineering Center.
INTEGRATION OF AIRBORNE DATA RECORDERS AND GROUND-BASED COMPUTERS FOR ENGINE MAINTENANCE PURPOSES
R. A. Rogers [1967] 20 p Presented at FAA Maintenance Symp. on Maintainability and Reliability of Aircraft Systems, Oklahoma City, 7–9 Nov. 1967
(AD-664383) CFSTI: HC $3.00/MF $0.65

The engine maintenance recorder portion of the data system consists of four major components: (1) Airborne magnetic data recorders, (2) Conventional long distance telephone data transmission links, (3) A centralized, ground-based, electronic computer complex,

(4) Computer programming which permits automatic diagnosis of engine health, fault identification, and measurement of the urgency for corrective action. This integrated system is part of what is known as ASTROLOG. The other parts of the ASTROLOG include FAA crash recording capability on an extra channel of the existing voice recorder, and a continuously recording, magnetic tape, flight performance recorder. Highlights of the engine maintenance recorder portion of the ASTROLOG are discussed. TAB

N68-18611# Allegheny Airlines, Inc., Pittsburgh, Pa.
FUTURE APPLICATIONS OF MAINTENANCE RELIABILITY SYSTEMS FOR THE SMALL FLEET OPERATOR
R. J. Masiello Nov. 1967 10 p Presented at FAA Maintenance Symp., Oklahoma City, 7–9 Nov. 1967
(AD-664375) CFSTI: HC $3.00/MF $0.65

The report discusses application of reliability systems by expanding data base of small fleet operators, i.e., Concorde, Airbus and DC-9 by pooling experience across corporate lines. Positive fall out of reliability systems is the necessity to manage. Reliability systems systemize the measure, analyze, and repair loop. Decreased dependence upon diagnostic and correction capability of individuals or single operators is noted. Wider use of reliability systems in the future will reduce cockpit workload associated with operational status of equipment. Author (TAB)

N68-18665# American Airlines, Inc., Tulsa, Okla. Maintenance and Engineering Center.
THE VALUE OF MAINTENANCE
[1967] 30 p ref Presented at the FAA R and M Symp., Oklahoma City, 8 Nov. 1967
(AD-664382)

The application of management research and electronic data processing equipment to produce an integrated maintenance control system is briefly discussed. A particular application entitled CRAM is reviewed as an example of how the computer has been applied to confirm theoretically-derived and intuitive conclusions that the failure resistance of complex systems and components is not always predictable or improvable by scheduled (time-controlled) maintenance programs. Author (TAB)

N68-18671# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
BALANCING QUALITY OF AN AIRCRAFT WITH A COMBINED CONFIGURATION [BALANSIROVOCHNOYE KACHESTVO SAMOLETA KOMBINIROVANNOY SKHEMY]
S. Yu. Skripnichenko *In its* News of Inst. of Higher Learning. Aeron. Eng. 10 Apr. 1967 p 17–26 refs (See N68-18668 09-23)

The physical and mathematical conditions for longitudinal stability of a canard type aircraft with tail control surfaces are considered. An analytical expression for the balancing polar is established for two possible solutions for the control of both horizontal surfaces, that is: 1) when one of the surfaces is deflected at a constant angle and the second is used as the controlling surface, and 2) when both surfaces are used as controlling surfaces and may be deflected to the optimal angles which correspond to minimum drag, thus assuring minimum lift-drag ratio balancing losses. The considered configuration is compared with conventional and canard configurations having equal parameters, and it is shown that the considered configuration is intermediate between the conventional and canard configurations with respect to the ratio of the L/D coefficient of the balanced aircraft and to the L/D coefficient of an unbalanced aircraft of canard configuration without a tail surface and with an equal total lifting surface. Author

N68-18697# Douglas Aircraft Co., Inc., Long Beach, Calif. Aircraft Div.
PREDICTIVE MAINTENANCE, FORLORN HOPE OR FORESEEABLE REALITY
R. V. Mac Gregor [1967] 31 p
(AD-664371) CFSTI: HC $3.00/MF $0.65

Consideration is given to predicting the maintenance of functional subsystems and components of aircraft based on the theory that it is better to detect and correct deteriorating functional conditions than to isolate and correct active malfunctions or failures. The prerequisites of predictive maintenance are delineated, and the problems of identifying and specifying probable modes of malfunction or failure are illustrated. A distinction is drawn between functional perfection and malfunction, and an assessment is made of three characteristic modes of malfunction and the time factor which is involved. The provisions which make it possible to determine and measure deterioration in the hydraulic subsystems, mechanical/electrical subsystems, and components of the DC-9 are discussed. The future applications of predictive maintenance are briefly mentioned in relation to an onboard computer that can provide instantaneous malfunction detection and fault isolation capabilities. B.S.D.

N68-18701# Atlantic Aviation Corp., Wilmington, Del.
MAINTAINABILITY AND RELIABILITY OF AIRCRAFT SYSTEMS
John G. Hite 9 Nov. 1967 10 p Presented at FAA Maintenance Symp., Oklahoma City, 7–9 Nov. 1967
(AD-664380) CFSTI: HC $3.00/MF $0.65

Topics include: Why do we need maintainability; How does a manufacturer obtain maintainability; Who can detect the need for something lacking in systems maintainability; Some prime examples of poor maintainability; Systems maintainability in the future. TAB

N68-18713# Trans World Airlines, Inc., Kansas City, Mo.
CONTROL OF PERIODIC MAINTENANCE THROUGH RELIABILITY ANALYSIS SYSTEMS
B. M. Meador [1967] 6 p Presented at the FAA Maintenance Symp., Oklahoma City, Nov. 1967
(AD-664374)

A general discussion is presented on methods of improving reliability of commercial aircraft. TAB

N68-18716# Federal Aviation Agency, Oklahoma City, Okla. Dept. of Transportation.
PHILOSOPHY ON EVALUATION OF MAINTENANCE PROGRAMS FOR NEW AIRCRAFT
S. J. Corso 1967 8 p Presented at the Maintenance Symp., Oklahoma City, 9 Nov. 1967
(AD-664387)

The outline of philosophy on the maintenance of new airplanes is an attempt to gather together all those currently known elements involving maintenance as a basis for providing reasonable assurance that the airplane can be maintained in the highest possible condition for safe operation. A separate paper entitled Federal Aviation Administration philosophy on evaluation of proposed maintenance programs for new large turbine and supersonic transport aircraft is included. TAB

N68-18722# Boeing Co., Renton, Wash. Supersonic Transport Branch.
RELIABILITY, MAINTAINABILITY CONCEPTS AND TECHNIQUES IN DESIGN OF AIRCRAFT SYSTEMS AND COMPONENTS
[1967] 22 p
(AD-664370) CFSTI: HC $3.00/MF $0.65

The paper discusses the subsonic service experience, the application of this experience to the design of the Mach 2.7 SST, and the establishment of definitive reliability and maintainability goals for each SST subsystem. These goals were established, based on Boeings analysis of the airline experience, with appropriate factors applied to account for the differences in supersonic and

subsonic flight profiles, flight and ground environments, and subsystem configurations. The SST landing gear and hydraulic subsystems were selected to illustrate the manner in which reliability and maintainability requirements, compatible with the continuing changes in airline maintenance concepts, have been incorporated into the SST design. In addition, the manner by which these design improvements were analyzed with respect to their effect on dispatch and block-to-block reliability and maintenance man-hours and task times is reviewed. The paper also briefly discusses how the reliability, maintainability, safety, and human engineering programs are integrated with the current SST design effort to provide Boeing, the FAA, and airline management with visibility and assurance that the program goals will be met. Author (TAB)

N68-18771*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

LARGE-SCALE WIND-TUNNEL TESTS OF A DEFLECTED SLIPSTREAM STOL MODEL WITH WINGS OF VARIOUS ASPECT RATIOS

V. Robert Page, Stanley O. Dickinson, and Wallace H. Deckert Washington Mar. 1968 56 p refs

(NASA-TN-D-4448) CFSTI: HC $3.00/MF $0.65 CSCL 01B

A wind-tunnel investigation was conducted to determine the longitudinal force characteristics of a large-scale model representative of a propeller-driven STOL transport aircraft. Longitudinal characteristics were obtained for a wing of aspect ratio of 5.7 that was fully immersed in the propeller slipstream and for wings of greater span (up to aspect ratio 8.1) that were only partially immersed in the propeller slipstream. Test configurations included: three wing spans, full-span leading-edge slats, full-span triple-slotted trailing-edge flaps deflected from 0° to 100°, two directions of propeller rotation, and spanwise variation of propeller thrust. Test results show that lift coefficient increased and drag coefficient decreased as the wing tips were extended outboard. Leading-edge slats controlled the progression of flow separation and extended the angle of attack for maximum lift approximately 10° For each wing span tested descent capability could be improved by spanwise variation of propeller thrust. However, the spanwise variation of propeller thrust was most effective on the short span wing. Author

N68-18814# Eastern Air Lines, Inc., Miami, Fla. Power Plant Engineering.

EASTERN AIR LINES' REAP: RELIABILITY ENGINEERING ANALYSIS AND PLANNING PROGRAM

Max Dow 7 Nov. 1967 47 p refs Presented at FAA Ann. Maintenance Symp., Oklahoma City, 7 Nov. 1967

(AD-664377)

REAP embraces the essential principles set out in the FAA Handbook for Maintenance Control by Reliability Methods. These principles include: (1) Measure and audit. (2) Check and balance in decision making. (3) Maximum decentralization for flexibility and responsibility plus communication to a central FAA. TAB

N68-19018*# National Aeronautics and Space Administration, Washington, D. C.

FLIGHT HANDLING QUALITY PROBLEMS POSED BY SWEPT-WING TRANSPORT PLANES WITHOUT TAIL UNITS [QUELQUES PROBLEMES DE QUALITES DE VOL POSES PAR LES AVIONS DE TRANSPORT A AILE ELANCEE SANS EMPENNAGE]

P. Lecomte and E. Fage Jun. 1966 60 p refs Presented at the 28th Meeting of the Flight Mech. Group of AGARD

(NASA-TT-F-10204) CFSTI: HC $3.00/MF $0.65 CSCL 01C

A new generation of swept wing, tail-less, and somewhat heavy planes is being born. These airplanes have many new features, being different from both delta winged warplanes and moderately swept wing transport planes. Some of these unusual features are analyzed from the viewpoint of the pilot's numerous tasks, and the applicability of some classic or new criteria is studied. A somewhat wide scanning of the possible characteristics is made concerning the lateral flight qualities. This scanning shows the complexity of the problem and the mutual influence of the various criteria that come into play. Emphasis is put into the special low velocity type of behavior, in connection with the longitudinal flight qualities. It is concluded that the critical points are different for these planes than for their predecessors, and that the standards of judgment must be rethought. As a whole however these flight qualities, while being different from those of their predecessors, compare favorably with them. Author

N68-19066*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

WING SURFACE PRESSURE DATA FROM LARGE-SCALE WIND-TUNNEL TESTS OF A PROPELLER-DRIVEN STOL MODEL

V. Robert Page and Paul T. Soderman Washington Mar. 1968 65 p ref

(NASA-TM-X-1527) CFSTI: HC $3.00/MF $0.65 CSCL 01C

The model tested is representative of a propeller-driven STOL transport aircraft. The variables include the effect of: trailing-edge flap deflection (0° to 100°), spanwise variation of propeller thrust, wing leading-edge slats, and propeller thrust and rotation on the three wing spans tested. Wing pressure distribution data and integrated chordwise normal-force coefficients are tabulated. Author

N68-19184*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

FLIGHT INVESTIGATION TO DETERMINE THE EFFECT OF LONGITUDINAL CHARACTERISTICS ON LOW-SPEED INSTRUMENT OPERATION

Daniel J. Di Carlo, James R. Kelly, and Robert W. Sommer Washington Mar. 1968 22 p refs

(NASA-TN-D-4364) CFSTI: HC $3.00/MF $0.65 CSCL 01D

A flight investigation using a variable-stability helicopter was conducted under instrument flight rules (IFR) to determine the effects of gross changes in longitudinal static stability characteristics on handling qualities for V/STOL operation. Various combinations of angle-of-attack stability, speed stability, pitch-rate damping, and longitudinal control sensitivity were evaluated by means of a simulated instrument task which was selected as being representative of low-speed instrument flight. Neutral to slightly stable angle-of-attack stability was found to be most satisfactory, regardless of the level of pitch-rate damping. Low unstable values of angle-of-attack stability were tolerable when sufficient pitch-rate damping was provided. Combinations of angle-of-attack stability and pitch-rate damping which provide minimum satisfactory handling qualities are in general agreement with current specifications for low values of angle-of-attack stability. Variations in the longitudinal control sensitivity had little effect on pilot rating over a wide range of values centered about the optimum tested. Author

N68-19212*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

RESEARCH APPROACHES TO ALLEVIATION OF AIRPORT-COMMUNITY NOISE

Harvey H. Hubbard, Domenic J. Maglieri, and W. Latham Copeland 6 May 1966 36 p refs Presented at the Inaugural Meeting of the Brit. Acoust. Soc., London, 6 May 1966

(NASA-TM-X-57689) CFSTI: HC $3.00/MF $0.65 CSCL 01B

The material of this paper relates to the problem of noise in communities near commercial airports due to landing and take-off operations and contains a description of some of the related NASA sponsored research toward its alleviation. The objectives of the paper are to identify some of the significant factors involved, and to present pertinent research information from NASA in-house and contract studies. Data are included to illustrate the significance

of such factors as aircraft engine type, compressor configuration, nacelle location and design, power reductions during climbout, steep angle landing approach profiles, and compatible land usage, with regard to noise alleviation and human response implications.
Author

N68-19325# Advisory Group for Aerospace Research and Development, Paris (France).
AEROMEDICAL ASPECTS OF HELICOPTER OPERATIONS IN THE TACTICAL SITUATION
May 1967 279 p refs In ENGLISH and FRENCH Proc. of AGARD Aerospace Med. Panel Symp., Paris, 22–24 May 1967 (AGARD-CP-24) CFSTI: HC $3.00/MF $0.65

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2. THE HELICOPTER AS A CASUALTY EVACUATION VEHICLE E. Evrard, F. J. Mills, E. Lail, I. Capperauld, R. F. Brown et al p 61–145 refs (See N68-19327 09-02)

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4. HAZARDS OF THE HELICOPTERS T. R. Ringer, J. R. Stallabrass, R. D. Price, I. H. Colley, F. T. Thomasson et al p 191–272 refs (See N68-19329 09-02)

N68-19326# Advisory Group for Aerospace Research and Development, Paris (France).
THE HELICOPTER AS A CARRIER OF PERSONNEL AND MATERIAL
R. L. Cody, D. L. Eley, P. J. Williams, M. W. B. Watson, C. J. Buckley et al *In its* Aeromed. Aspects of Helicopter Operations in the Tactical Situation May 1967 p 1–59 (See N68-19235 09-02)

The development of helicopters in military and medical tactics is reviewed. Helicopter order of battle data are discussed in terms of tactics employed, mobility, fire power, logistics, and command. The application of helicopters to rescue operations is examined, and the use of rescue personnel trained as medics, parachutists, and in the use of SCUBA gear is described. The practicability of helicopter operations in civil disaster casuality control is demonstrated. Air refueling is shown to be feasible in rescue type operations. The man–machine relationship is examined with crew performance, training, fatigue, etc. stressed. E.J.S.

N68-19327# Advisory Group for Aerospace Research and Development, Paris (France).
THE HELICOPTER AS A CASUALTY EVACUATION VEHICLE
E. Evrard, F. J. Mills, E. Lail, I. Capperauld, R. F. Brown et al *In its* Aeromed. Aspects of Helicopter Operations in the Tactical Situation May 1967 p 61–145 refs In ENGLISH and FRENCH (See N68-19325 09-02)

Efforts towards extending and modernizing the provisions of the Geneva conventions are reviewed. The role of helicopters in casualty and evacuation operations is described in many areas of the world, from impenetrable jungle to arid mountain top. The question of air superiority is discussed in terms of providing air cover for helicopters on aeromedical missions. The principal advantages to a helicopter as a evacuation vehicle are described as: the clinical advantage of transporting the battle casualty out of the combat zone and back to a surgical unit with a minimum loss of time; the morale of the solider going into battle is maintained if he knows that a helicopter is available to transport him to a hospital if wounded; the ability of the helicopter to extract casualties from otherwise inaccessible locations. Recommendations are presented for cooperation in research and development of helicopter evacuation equipment, for standardization of communications and signal procedures, and for education and training of ground forces in the requirements and abilities of the helicopter pilot landing in combat zones or difficult terrain. E.J.S.

N68-19328# Advisory Group for Aerospace Research and Development, Paris (France).
AIRCREW PROBLEMS IN HELICOPTER OPERATIONS
S. Neel, W. A. N. Mackie, H. Seris, A. Auffret, J. T. Adams et al *In its* Aeromed. Aspects of Helicopter Operations in the Tactical Situation May 1967 p 147–189 refs In ENGLISH and FRENCH (See N68-19325 09-02)

The noise problem and certain aspects of toxicology such as the measurement of very low concentrations of dangerous, toxic, or even potentially hazardous substances in the cockpit, are discussed with respect to helicopter rescue and evacuation operations. The necessity of correct interpretation of all visual cues and the importance of the angle of vision are pointed out. Preliminary data are presented on vibratory effects of helicopter flight and on the incidence of helicopter pilots complaining of pains in the spinal region. The development, characteristics, and importance of flight fatigue in a combat unit are examined in detail. Various approaches to the training of helicopter pilots are compared. E.J.S.

N68-19329# Advisory Group for Aerospace Research and Development, Paris (France).
HAZARDS OF THE HELICOPTERS
T. R. Ringer, J. R. Stallabrass, R. D. Price, I. H. Colley, F. T. Thomasson et al *In its* Aeromed. Aspects of Helicopter Operations in the Tactical Situation May 1967 p 191–272 refs (See N68-19325 09-02)

Icing of helicopters engaged in rescue/evacuation operations is discussed, and thermal, electrical, and chemical methods are described for its prevention and/or elimination. The hazards of overwater flight are reviewed and procedures are outlined for escape from a ditched helicopter. A personnel escape, protection, and survival capsule for helicopters is described. Crash injuries in US Army helicopter accidents are tabulated, and recommended techniques for emergency landing and ditching of helicopters are presented. E.J.S.

N68-19405# Air Registration Board, London (England).
AIRWORTHINESS REQUIREMENTS FOR SUPERSONIC TRANSPORT AIRCRAFT IN A HYDROMETEOR ENVIRONMENT
L. S. Edwards *In* RAE Rain Erosion and Assoc. Phenomena Aug. 1967 p 42–56 refs (See N68-19401 09-13)

Structural airworthiness requirements for supersonic aircrafts encountering rain, hail, ice crystals, and icing are formed by comparing French, British, and American environmental hydrometeor standards. Structural requirements for aircraft survival in adverse hydrometeor conditions can be evaluated by simulation model tests, and flight mission analyses whereby the aircraft is projected through a probability spectrum of rain intensity, maximum quantities of supercooled water droplets in the atmosphere, or ice crystal clouds. G.G.

N68-19461# Massachusetts Inst. of Tech., Cambridge. Engineering Projects Lab.
DYNAMICS OF SIMPLE AIR-SUPPORTED VEHICLES OPERATING OVER IRREGULAR GUIDEWAYS
H. H. Richardson, K. M. Captain, and W. A. Ribich Jun. 1967 55 p refs
(Contract C-85-65)
(DSR-76110-4; PB-173655) CFSTI: HC $3.00/MF $0.65

The simplest appropriate dynamic model for fluid suspensions, a dynamic spring with lead and lag, is used to study the vertical displacement and acceleration of a vehicle moving over a guideway containing deterministic and random irregularities. The analysis is limited to heave motion and to irregularity wavelengths long

relative to the suspension length. For any value of lead time constant an optimum lag time constant is shown to exist which minimizes vehicle acceleration and which may be achieved by adjusting the dead volume in the fluid suspension. The general results are applied to a simple rigid-walled plenum. Relations for acceleration, relative displacement, mass flow and pumping power are presented as functions of cushion geometry, loading, and hover height. The dynamic lead is shown to depend primarily on the vehicle weight and area and to be a primary factor determining maximum acceleration. For typical vehicle weights and sizes it is shown that optimum dynamic lead cannot be physically realized in a simple plenum suspension. Further the results obtained in this simple analysis suggest that it will be very difficult to achieve adequate passenger comfort at HSGT speeds over realistic guideways through use of only primary rigid simple plenum suspensions. Author

03 AUXILIARY SYSTEMS

Includes fuel cells, energy conversion cells, and solar cells; auxiliary gas turbines; hydraulic, pneumatic and electrical systems; actuators; and inverters. For related information see also: 09 Electronic Equipment; 22 Nuclear Engineering; and 28 Propulsion Systems.

N68-18351*# Texas Instruments, Inc., Dallas.
SOLAR-CELL INTEGRAL COVER-GLASS DEVELOPMENT
Progress Report, 1 Jun.–31 Aug. 1967
31 Aug. 1967 28 p
(Contract NAS5-10319)
(NASA-CR-93410; Rept.-03-67-101; PR-2) CFSTI: HC $3.00/MF $0.65 CSCL 10A

This report presents progress on a research and development program for applying integral cover-glass coatings to silicon solar cells by radio-frequency sputtering. Integral coatings of 7940 fused silica up to 4.2 mils have been deposited during this period. Sputtering equipment modifications have increased the deposition rate and uniformity. Deposition rates as high as 2400 Å/min (0.57 mil/hr) have been observed on this equipment. The majority of the work in this reporting period was directed toward developing the anti-reflective coating between the silicon solar cell and the integral 7940 fused-silica coverslide. Solar cells coated with nominal 575 Å of CeO_2 consistently have shown an increase in conversion efficiency after integral coating. Sunlight data should show the CeO_2 integrally-coated cell to be more efficient than the standard, silicon-monoxide-coated cells without protective covers. Author

N68-18360# Army Electronics Labs., Fort Monmouth, N. J.
COMPARATIVE HIGH RATE PERFORMANCE OF RESERVE BATTERIES WITH ORGANIC OR MAGNESIUM PERCHLORATE ELECTROLYTE
Nicholas T. Wilburn, Achille L. Almerini, and Charles J. Bradley Sep. 1967 76 p
(ECOM-2880; AD-664153) CFSTI: HC $3.00/MF $0.65

Moderately high rate organic electrolyte batteries were recently developed. A program was conducted to evaluate their performance in comparison to the fairly well-established magnesium-manganese dioxide system with an aqueous magnesium perchlorate electrolyte which, as a reserve type battery, is being investigated for use as a lightweight, all temperature power source for modern communications equipment, notably the AN/PRC-62. Batteries of both systems were evaluated under a range of conditions to establish general feasibility for the AN/PRC-62 application. TAB

N68-18451*# Texas Instruments, Inc., Dallas. Semiconductor-Components Div.
SOLAR-CELL INTEGRAL COVER-GLASS DEVELOPMENT
Progress Report, 10 Feb.–31 May 1967
31 May 1967 30 p refs
(Contract NAS5-10319)
(NASA-CR-93408; Rept.-03-67-51; PR-1) CFSTI: HC $3.00/MF $0.65 CSCL 10A

Progress is reported on a research and development program for applying integral cover-glass coatings to silicon solar cells by radio-frequency sputtering. Integral quartz coatings up to 3.5 mils thickness have been deposited on standard solar cells at a rate of approximately 1200 Å/min by RF sputtering. The process variables that affect deposition rate have been investigated, with 2100 Å/min of quartz the highest rate obtained. One-mil-thick integral coatings have been subjected to thermal shock from −196°C to +100°C with no apparent degradation or delamination from the solar cell. The stress of RF-deposited quartz films on silicon has been measured versus film thickness. The results shown that maximum stresses involved are much less than the compressive strength of SiO_2. Initial quartz depositions on standard solar cells yielded approximately 10% decrease in short-circuit current of the cell under 100 mW/cm^2 tungsten light. Radio-frequency sputtering has the advantage of high deposition rate on low-stress, high-optical-quality quartz films. The substrate temperature can easily be maintained at less than 200°C throughout the deposition, which prevents damage to the solar-cell coating, contacts, and junction. Author

N68-18466# European Space Technology Center, Noordwijk (Netherlands).
SATELLITE POWER-CONDITIONING AND CONTROL: A SUMMARY OF DESIGN POSSIBILITIES
A. W. Preukschat Paris ESRO Oct. 1967 21 p
(ESRO-TM-54(ESTEC)) CFSTI: HC $3.00/MF $0.65

This paper deals with the power conditioning and control system of a solar cell array–battery power supply for satellites. Following a functional description, the general requirements and features of possible subsystems are discussed. Author (ESRO)

N68-18501*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXPERIMENTAL PERFORMANCE EVALUATION OF AN 8.5 INCH (21.59 CM) MEAN-DIAMETER AXIAL FLOW TURBINE AT REYNOLDS NUMBERS FROM 18,000 TO 177,000
William J. Nusbaum and Milton G. Kofskey Washington Mar. 1968 21 p refs
(NASA-TN-D-4432) CFSTI: HC $3.00/MF $0.65 CSCL 10A

An experimental investigation of an 8.5-inch- (21.59-cm-) mean-diameter, two-stage, axial-flow turbine was conducted to determine the effect of a change in Reynolds number on the performance of a turbine of this type and size. The investigation was conducted with cold argon over a range of inlet pressures from about 1.0 to 9.0 psia (0.68 to 6.2 N/cm^2 abs) with corresponding Reynolds numbers from 18,000 to 177,000. At each value of turbine-inlet pressure, data were taken at design equivalent speed and various pressure ratios. Results of the investigation indicated that at design equivalent speed and pressure ratio an increase in Reynolds number resulted in a 5.8 percent increase in mass flow over the range of Reynolds number covered. The total efficiency at design equivalent speed and pressure ratio increased from 0.82 to 0.88 with an increase in Reynolds number over the same range. The corresponding static efficiency increased from 0.80 to 0.86. The variation in loss with change in Reynolds number agreed well with a theoretical variation, wherein 0.7 of the loss was attributed to viscous losses and the remaining 0.3 was attributed to other losses which are independent of Reynolds number. Author

N68-18503*# Radio Corp. of America, Princeton, N. J. Astro-Electronics Div.
ADVANCED VOLTAGE REGULATOR TECHNIQUES AS APPLIED TO MAXIMUM POWER POINT TRACKING SYSTEMS FOR THE NIMBUS METEOROLOGICAI SATELLITE Final Report, 16 Jun. 1965–10 Oct. 1967
10 Oct. 1967 158 p refs
(Contract NAS5-3248)
(NASA-CR-93413; AED-R-3221) CFSTI: HC $3.00/MF $0.65 CSCL 10B

Background and development are considered for practical Maximum Power Point Tracking (MPPT) space power systems adapted from the basic technology of pulse width modulated switching voltage regulators. While the MPPT system is oriented toward Nimbus meteorological satellite power supply, the concepts and techniques are considered applicable to most spacecraft and to a wide variety of power system configurations. System design and operation are described, and details are included for the experimental model which preceded the proposed second generation MPPT system. Source characteristics, multiplier, peak detector, pulse absence detector, toggle, and load are discussed for the MPPT system; and system protective mode operation is considered along with the high speed circuits employed in the second-generation system. M.W.R.

N68-18509 Australian National Univ., Canberra. Dept. of Engineering Physics.
CEMENTING ROTORS FOR THE CANBERRA HOMOPOLAR GENERATOR
L. U. Hibbard Apr. 1967 47 p refs
(EP-RR-1) Available from the Australian Natl. Univ. Press, P.O. Box 4, Canberra, A.C.T., 2600, Australia: HC $A1.00

A description is given of the cementing together of two 20-ton steel discs to form a composite 40-ton rotor, 139 in. in diameter and 20 in. in thickness, which functions as a two-turn winding of the homopolar generator. The bond between the steel discs is required to withstand a 200-volt difference in potential and large mechanical forces due to temperature differences and short circuit currents. The bottom rotor pair was cemented first, followed by the top rotor pair. Author

N68-18551 Australian National Univ., Canberra. Dept. of Engineering Physics.
THE DESIGN OF BRUSHES FOR THE CANBERRA HOMOPOLAR GENERATOR
R. A. Marshall Apr. 1967 51 p refs
(EP-RR-3) Available from the Australian Natl. Univ. Press, P.O. Box 4, Canberra, A.C.T., 2600, Australia: HC $A1.00

An account is given of the factors involved in the designing of solid brushes to take the full current pulse of 1.6 million amps for one second from the homopolar generator. The generator was originally designed to provide the power for the air-cored orbital magnet of a 10-GeV proton synchrotron, but it is now regarded as a source of high currents for some seconds. This report describes the functional requirements of the brushes regarding pulse types, current-time, and location. Results are presented of experiments with the brushes at a speed of 550 ft/sec and at pulse current densities of 100,000 amp/in^2, using an 18-1/2-in. diameter rotor of mild steel rotating up to 6,600 rpm. Covered in the report are also brush size and voltage gradient, calculation of rotor surface temperature, thermal stress cycling in rotors, cooling, and rotor reversal effects. K.W.

N68-18691# Lockheed-Georgia Co., Marietta.
RELIABILITY PREDICTIONS FROM AN ART TO A SCIENCE
K. S. Wilson 7 Nov. 1967 9 p Presented at FAA Symp., Oklahoma City, 7–9 Nov. 1967
(AD-664372)

The paper comments upon reliability predictions and the degree to which precise methods are being employed to make quantitative estimates of future reliability performance. The demand for high product reliability and maintainability is forcing attention to these subjects from the large system manufacturer down to the piece-part producer. Contracting for guaranteed reliability performance involves heavy risks, and accurate predictions are needed early in the program. The state-of-the-art in making precise quantitative reliability estimates in the airplane business is considered primitive and largely a matter of exercising judgment in combining bits of historical data and wishful thinking. A large portion of the aerospace industry is participating, and slow progress is being made toward the development of a worth-while and effective capability. Author (TAB)

N68-18698*# North American Rockwell Corp., Downey, Calif. Space Div.
TECHNOLOGICAL REQUIREMENTS COMMON TO MANNED PLANETARY MISSIONS. APPENDIX C: SUBSYSTEM SYNTHESIS AND PARAMETRIC ANALYSIS
R. D. Meston Jan. 1968 238 p refs
(Contract NAS2-3918)
(NASA-CR-73191; SD-67-621-4) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The environmental control and life support subsystem, communications subsystem, electrical power subsystem, and propulsion subsystem analyses which were conducted during the study are reported. Candidate environmental control and life support subsystems are defined in terms of weight, volume, and electrical power requirements for all manned modules. This includes the Earth reentry module, mission module, and both ascent and descent stages of the planetary excursion module. Several types of communications techniques are compared parametrically, and the range of power requirements is established. Propulsion subsystem weight scaling equations are developed and the characteristics of candidate propellants established. All promising power generation (including nuclear reactor, radioisotope, and solar) and conversion system combinations are compared. Weights, volumes, and areas are provided along with qualitative analyses of the integration factors. Author

N68-18702*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
DYNAMIC CHARACTERISTICS OF PARASITIC LOADING SPEED CONTROLLER FOR 10 KILOWATT BRAYTON CYCLE TURBOALTERNATOR
Raymond L. E. Fischer and Darryl J. Droba Washington Mar. 1968 18 p refs
(NASA-TM-X-1456) CFSTI: HC $3.00/MF $0.65 CSCL 10B

An investigation was conducted to determine the operating characteristics of a static parasitic-loading speed controller, including the transient and off-design characteristics, when operating with an air driven turboalternator. The speed controller was designed to be used with the turboalternator in a 400 hertz Brayton cycle power conversion system. The speed controller begins to deliver power to the parasitic load when the turboalternator output frequency increases above the rated frequency of 400 hertz, and it delivers maximum power to the load when the frequency reaches 406 hertz. With this controller, the system speed was maintained within 2 percent for voltage variations from 140 to 92 volts and step load changes of 10 kilowatts, with an alternator output of 10.5 kilowatts. Author

N68-18709*# American Univ., Washington, D. C.
RESEARCH INTO FUNDAMENTAL PHENOMENA ASSOCIATED WITH SPACECRAFT ELECTROCHEMICAL DEVICES—CALORIMETRY OF NICKEL–CADMIUM CELLS Progress Report, 1 Apr.–30 Jun. 1967

G. D. Mitchell and R. T. Foley 30 Jun. 1967 20 p
(Contract NAS5-10105)
(NASA-CR-93430; PR-4) CFSTI: HC $3.00/MF $0.65 CSCL 10C

Reported are calorimetric measurements on nickel–cadmium cells of various capacities undergoing discharge at depths of 15, 25, and 40%, and recharge at 110%. Changes were made in the system to accommodate the larger 20 ampere-hour cell and to increase the reproducibility and sensitivity of the heat measurement. These changes included rebuilding the external heat exchanger, altering the flow pattern of the oil through the calorimeter, and fabricating an improved thermopile. Calibration experiments on the heater and the pressure transducer were performed. Data from the charge efficiency study on the six ampere hour cell were replotted to better represent the heat dissipation problem. Author

N68-18719*# Pennsylvania Research Associates, Inc., Philadelphia.
ADVANCED FUEL CELL CATALYSTS Status Report, 10 Nov. 1967–10 Feb. 1968
Carlo V. Bocciarelli 10 Feb. 1968 46 p refs
(Contract NAS7-574)
(NASA-CR-93426; EC-SR-3) CFSTI: HC $3.00/MF $0.65 CSCL 10A

New approaches, based on the dependance of electrocatalysis on the surface properties of metal catalysts, were examined in an effort to develop a substitute for platinum on the oxygen side of an oxygen-hydrogen fuel cell. The preparation of noble metal catalysts with fully repeatable characteristics superior to platinum in the low current region is detailed, and experimental evidence is presented to show that these catalysts are significant improvements on platinum bright. E.J.S.

N68-18826*# General Electric Co., Gainesville, Fla. Battery Business Section.
CHARACTERIZATION OF RECOMBINATION AND CONTROL ELECTRODES FOR SPACECRAFT NICKEL CADMIUM CELLS Final Report
W. N. Carson, Jr., G. Rampel, and I. B. Weinstock Jan. 1968 111 p
(Contract NAS5-10261)
(NASA-CR-93427) CFSTI: HC $3.00/MF $0.65 CSCL 10C

Oxygen signal and recombination electrodes were developed to provide reliable charge control for spacecraft nickel–cadmium cells operable over a −20°C to +40°C temperature range in near-earth orbits to cycle depths of 75%. The signal electrode voltage output was essentially proportional to oxygen pressure in the range of 5 to 30 psia. Performance was constant during the test program. The electrode's rate of oxygen recombination was greater than required to reduce pressure between charge cycles. The electrode is also active in recombining any hydrogen formed in the cell. It was possible to operate cells with the negative electrodes nearly fully charged. The cycle capability was greater by a factor of more than 10 at 40°C to 50% DOD and more than 8 at 25°C to 75% DOD. The cycle regime of cells was altered without a reconditioning procedure, indicating that the "memory effect" has been greatly reduced. Author

N68-18828*# Allmanna Svenska Elektriska A. B., Vasteras (Sweden). Chemistry Lab.
RESEARCH ON THE POLARIZATION IN POROUS OXYGEN ELECTRODES Quarterly Report, 1 Oct.–31 Dec. 1967
Ingemar Lindholm and Ingrid Edwardsson 24 Jan. 1968 51 p refs
(Contract NASw-1536)
(NASA-CR-93486; QR-3) CFSTI: HC $3.00/MF $0.65 CSCL 10C

A program designed to study mass transport polarization and activation polarization in porous oxygen electrodes is reported. Polarization in porous nickel electrodes was measured with varying electrocatalysts, silver, palladium and platinum. The mass transport properties of the KOH electrolyte, e.g. oxygen solubility, oxygen diffusivity, and ionic conductivity were varied by changing the KOH concentration from 1M KOH to 10 M KOH at 50°C and the temperature from 25°C to 85°C with 7 M KOH. Polarization decay with time after current interruption was studied for Ag, Pd and Pt electrocatalysts. Author

N68-18861 Australian National Univ., Canberra. Dept. of Engineering Physics.
THE ELECTROLYTIC VARIABLE RESISTANCE TEST LOAD/SWITCH FOR THE CANBERRA HOMOPOLAR GENERATOR
R. A. Marshall Apr. 1967 32 p refs
(EP-RR-4) Available from the Australian Natl. Univ. Press, P.O. Box 4, Canberra, A.C.T., 2600, Australia: HC $A1.00

Test load description and characteristics are presented and use of load as a current control resistor switch are discussed for the electrolytic variable resistance test load/switch testing device for the Canberra Homopolar Generator (HPG). Operating characteristics of the full and quarter HPG are presented, the theory for load conductance is discussed, and a preliminary idea of the conductance time program required to take a classical pulse is included. Cam coordinates based on the required tank movement and current based on the tank movement, initial generator voltage, and electrolyte conductivity are given for classical pulse calculations. The fast pulse, emergency brake pulse, bus bar test cam, and cam manufacture are discussed. M.W.R.

N68-18862 Australian National Univ., Canberra. Dept. of Engineering Physics.
INSTRUMENTATION AND CONTROL OF THE CANBERRA HOMOPOLAR GENERATOR BY ON-LINE COMPUTER
I. D. G. Macleod Apr. 1967 54 p refs
(EP-RR-11) Available from the Australian Natl. Univ. Press, P.O. Box 4, Canberra, A.C.T., 2600, Australia: HC $A1.00

System requirements are described for the instrumentation and control of the Canberra homopolar generator by an on-line computer, and methods of implementing a system of data logging, automatic control, and alarm scanning for the HPG were investigationed. An implementation method is proposed on the basis of the system requirements; and data handling, malfunctions management, automatic control, and relationship between HPG programs and other users of the computer are discussed. An effective and relatively inexpensive on-line link with the computer facilities can be established by using an electric typewriter connected to the computer's 1827 data control unit. Additional features required for this unit as well as new equipment required are discussed, along with cost estimates for both. A DC coupled isolation amplifier and derivation of worst case specifications and selection of a suitable isolation amplifier are considered. Details are included regarding analog transducers presently installed on the HPG, including suggested groupings and amplifier circuits. M.W.R.

N68-18904 Australian National Univ., Canberra. Dept. of Engineering Physics.
THE DESIGN OF BRUSHES FOR THE HOMOPOLAR GENERATOR AT THE AUSTRALIAN NATIONAL UNIVERSITY
A. Stebbens (Morganite Res. and Develop., Ltd.) and H. Ward (Morganite Carbon, Ltd.) Sep. 1967 49 p refs Reissued
(EP-RR-18)

The performance of solid brushes under conditions associated with the duty cycle of the hompolar generator is assessed. Experiments were conducted to determine the feasibility of using conventional solid brushes for current collection, and to select the optimum brush grades for running under conditions of high speed, current density, and load. A copper–graphite grade CM1S was judged capable of meeting the required operating conditions. Detailed consideration was also given to brushgear design and the

conditions of brush operation. It was concluded that thermal stress of the rotor is a major problem at the rated output of the generator, and that much further work is required on brushgear design and the effects of magnetic forces before the brushes would prove practicable. M.G.J.

N68-18934# Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires.

ELECTRONIC CONTROL OF PLUTONIUM EXTRACTION BATTERY [CONTROLE ELECTRONIQUE D'UNE BATTERIE D'EXTRACTION DE PLUTONIUM]

Michel Degryse (Ph.D. Thesis—Paris Univ.) 1967 104 p refs In FRENCH

(CEA-R-3224)

Various aspects of the measurement of plutonium retention in an extraction battery using neutron detectors were studied. The static and dynamic tests carried out on the battery are described and an elementary theory concerning its method of operation is postulated. Two essential modes are defined: with and without leakage of plutonium into the refined liquid. The optimum operational conditions were determined. The control chain is described and the estimated performance given. The equilibrium and the transient states observed after regulation are compared with those calculated theoretically. Operational results obtained before and after regulation are also compared. Author (NSA)

N68-18998*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

ANALYSIS OF THE MAXIMUM PERFORMANCE OF A PARABOLOIDAL SOLAR COLLECTION SYSTEM FOR SPACE POWER

Gabriel N. Kaykaty Washington Mar. 1968 19 p refs

(NASA-TN-D-4415) CFSTI: HC $3.00/MF $0.65 CSCL 10B

An analytical study was performed to investigate the effects and interactions of the concentrator surface errors and rim angle, collection system orientation error, and cavity receiver operating temperature on the maximum thermal efficiency of a paraboloid collection system operating in the vicinity of the earth. The ranges investigated were: standard deviation of surface error (0 to 18 min), orientation error (0 to 30 min), receiver temperature (2000° to 4000°R or 1110° to 2200°K), and concentrator rim angle (45 to 60 deg). Results indicate that the surface error, orientation error, and receiver operating temperature each decidedly affect the collection efficiency and that these effects are interdependent. It is shown that surface and orientation error became increasingly important with increasing receiver operating temperature. A variation in rim angle, on the other hand, produces only a slight variation in collection efficiency and does not materially modify the effects of the other three parameters. This information can be applied to the more comprehensive design optimization of a solar power system with regard to such factors as weight, size, and manufacturing simplicity. Author

N68-19007*# General Electric Co., Cincinnati, Ohio. Missile and Space Div.

TWO STAGE POTASSIUM TURBINE—3000 HOUR TEST Final Report

E. Schnetzer, ed. Jul. 1967 256 p refs

(Contract NAS5-1143)

(NASA-CR-72273) CFSTI: HC $3.00/MF $0.65 CSCL 10A

After successfully completing 2000 hours test of a two-stage turbine with inlet potassium vapor at 1500°F and vapor quality at 99 percent, an additional 3000 hours test was completed at the same test conditions which included a second stage inlet vapor quality calculated to be 96.7 percent. The objective of both tests was to determine the resistance of rotor-blade refractory materials to liquid impact erosion and/or corrosion. These data are needed in the design of vapor turbines for use in Rankine-cycle space electric power generators. The conclusions from a detailed mechanical inspection, a thorough metallurgical evaluation and performance surveillance during testing are as follows: the turbine experienced no damage affecting its safety and reliability, the facility demonstrated its potentiality of supporting a long-duration endurance test especially by its characteristic of reducing the already low potassium purity level as testing progresses, only minor evidences of erosion and/or corrosion were observed on the turbine superalloy and refractory-metal parts, and no deterioration in turbine performance was noted. Author

N68-19019*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

CRITERIA FOR USE OF RANKINE-MHD SYSTEMS IN SPACE

Lester D. Nichols Washington 1966 24 p refs Presented at the Intern. Symp. on Magnetohydrodyn. Elec. Power Generation, Salzburg, Austria, 4–8 Jul. 1966

(NASA-TM-X-52191) CFSTI: HC $3.00/MF $0.65 CSCL 10B

A Rankine cycle that employs an MHD generator is being considered for use in space. These systems must be evaluated on the basis of minimum specific weight, which generally means minimum radiator area to reject the cycle waste heat. Limitations on materials, maximum available magnetic field strength, and the MHD power-generation process itself restrict the range of working fluid temperature and density. The maximum temperature (set by materials limitations) and the minimum radiator area criterion can be used to specify the operating temperature extremes. The operating pressure and density extremes are then determined by the choice of working fluid from the vapor-pressure curve. Since the conductivity increases with electron number density and decreases with increasing fluid density, it may be necessary to seed the working fluid to provide adequate electron concentration at the relatively high densities needed to heat the fluid. These considerations, coupled with the temperature requirements of the cycle, place restrictions on the choice of the seeded working fluid. Author

N68-19021*# Fairchild Hiller Corp., Germantown, Md. Space and Electronics Systems Div.

FABRICATION FEASIBILITY STUDY OF A 30 WATT/POUND ROLL-UP SOLAR ARRAY Quarterly Report, 1 Oct.–31 Dec. 1967

H. G. King 2 Feb. 1968 192 p refs Prepared for JPL

(Contracts NAS7-100; JPL-951969)

(NASA-CR-93595; Rept.-652-00102-QR; QR-2) CFSTI: HC $3.00/MF $0.65 CSCL 10A

During the reporting period, efforts were directed toward selection of the basic deployment/retraction mechanism and detail design of the associated array components. The final decision on selection of a deployment mechanism was based on: manufacturing feasibility; reliability; simplicity of design; state-of-the-art (1968) materials, processes and components; and a design that would meet the requirements of the design specification. A five element folding arm (three full links and two half links) was chosen for the deployment/retraction technique. The arms are three square inch corrugated tubes made of a boron/epoxy composite material which was selected for its high strength to weight ratio. One end of the extended arm is fastened to a substrate spreader bar located outboard of the array; the other end interfaces with the spacecraft. A cable and pulley system is used to program the motion of the folding arm joints. Author

N68-19110*# National Aeronautics and Space Administration. Joseph F. Kennedy Space Center, Cocoa Beach, Fla.

OPERATIONS AND MAINTENANCE MANUAL UPRATED SATURN 1 AND SATURN 5 VEHICLE STAGE PRESSURIZED LIGHTING SYSTEM

30 Dec. 1967 52 p

(NASA-TM-X-60906; TM-542) CFSTI: HC $3.00/MF $0.65 CSCL 22D

Information is presented on the function and operation of the uprated Saturn I and Saturn V launch vehicle stage safety lighting system. The detailed theory of operation, installation, special tools and equipment, adjustment, and maintenance procedures of the lighting system are discussed. Also included are a complete set of drawings and diagrams as well as a parts list. R.N.A.

N68-19128*# National Aeronautics and Space Administration, Washington, D. C.
ELECTRIC POWER GENERATION IN SPACE
Dec. 1967 20 p
(NASA Facts-NF-38) GPO: HC $0.20; CFSTI: MF $0.65 CSCL 10B

This educational facts pamphlet presents a comprehensive account of present and future electric power sources for space application. Covered are requirements and constraints of electric power generation in space, solar energy conversion, construction and functioning of solar cells, rechargeable batteries, fuel cells, thermoelectric and thermionic power plants and converters, the Brayton and Rankine cycles, and several Systems for Nuclear Auxiliary Power (SNAP) concepts. K.W.

N68-19247*# Boeing Co., Seattle, Wash. Space Div.
INTEGRATED MANNED INTERPLANETARY SPACECRAFT CONCEPT DEFINITION. VOLUME 6: COST EFFECTIVE SUBSYSTEM SELECTION AND EVOLUTIONARY DEVELOPMENT
Jan. 1968 288 p refs
(Contract NAS1-6774)
(NASA-CR-66564; D2-113544-6) CFSTI: HC $3.00/MF $0.65 CSCL 22B

This document investigates various ways of accomplishing power generation, waste water reclamation, environmental control, attitude control, and communications functions on manned space missions. Preferred concepts are identified by cost-effectiveness analyses, and a plan of evolutionary development is proposed for the preferred concepts. The subsystem analyses are conducted for an assumed flight program of four National Space Station missions and four interplanetary missions within the 1975 to 1990 time period. Author

N68-19334*# Ryan Aeronautical Co., San Diego, Calif. Electronic and Space Systems.
DEPLOYABLE LARGE AREA SOLAR CELL ARRAY TESTING Quarterly Report
15 Jan. 1968 73 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951107)
(NASA-CR-93670; Rept.-20867-1) CFSTI: HC $3.00/MF $0.65 CSCL 10A

The nondestructive dynamic testing and evaluation of the prototype deployable solar array support structure are reported. The work reported consists of a test plan and procedure, design layout and detail design of the modular solar cell installation, the 0.2g cruise maneuver acceleration test, application of active and dummy solar cells to the panel substrate, and final assembly of the solar array for testing. Also accomplished were design and fabrication of special support fixtures, vibration fixtures, and solar cell test equipment. Process development samples were prepared and a thermal-vacuum test was conducted to evaluate the effect of process variables on low temperature deployment of the solar array panel. Author

N68-19356*# TRW Systems, Redondo Beach, Calif.
OPERATION OF SOLAR CELL ARRAYS IN DILUTE STREAMING PLASMAS
Robert K. Cole, H. S. Ogawa, and J. M. Sellen, Jr. 15 Mar. 1968 63 p ref
(Contract NAS3-10612)
(NASA-CR-72376; TRW-09357-6006-R000) CFSTI: HC $3.00/MF $0.65 CSCL 10A

The operation of solar cell arrays in dilute streaming plasmas was examined. Plasma streams generated in a plasma wind tunnel were directed against solar cell panels. Ion mass, ion streaming velocities and plasma densities simulate, in general, conditions encountered by spacecraft orbiting in the lower ionosphere. Electron drainage currents from the plasma to the solar cell array were determined as functions of cell bias potential and plasma density. Solar cell bias potentials ranged from 0 to 3000 volts positive with respect to the plasma. Electron drainage currents at high cell bias potentials enacted severe power penalties against overall cell operation. Deterioration of cell insulating material with consequent increase in electron drainage current was observed. Electron drainage to representative drainage points with pinhole geometry and slit geometry was determined. Exact limits to cell potentials for continued non-deteriorative operation were not determined. Possible operating potentials, however, increase for decreases in plasma density corresponding to increased spacecraft altitudes. Author

N68-19362*# Tyco Labs., Inc., Waltham, Mass.
DEVELOPMENT OF CATHODIC ELECTROCATALYSTS FOR USE IN LOW TEMPERATURE H_2/O_2 FUEL CELLS WITH AN ALKALINE ELECTROLYTE Quarterly Report, 1 Oct.–31 Dec. 1967
J. Giner, J. Parry, L. Swette, and R. Cattabriga 31 Dec. 1967 34 p
(Contract NASw-1233)
(NASA-CR-93666; Q-10) CFSTI: HC $3.00/MF $0.65 CSCL 10A

The test rig for studying the life of cathode catalysts for O^2 reduction is described. Particular attention is paid to carrying out the tests under realistic conditions but under circumstances that avoid the more common failure modes of H_2/O_2 cell. The apparatus and conditions for testing the catalysts are reported along with results from tests conducted on 60 Au/40 Pd, a platinum electrode, and an AB-40 which is to provide a standard for cell behavior. Other catalysts tested include the alloys, carbides, and nitrocarbides of 3 Ni/Au, Ni/3 Au, 3 Ni/Pt, and 3 Ni/Ag. Details are also given on the preparation of the various catalysts discussed. A mathematical approach to the operation of the polytetrafluorethylene (PTFE) bonded electrode is outlined. The objective of this approach is to be able to predict the effect on electrode performance of readily measurible characteristics of the catalyst such as the exchange current, the surface area per unit volume, the microporosity, macroporosity, pore size distribution and agglomerate size, and the physical characteristics of the system. B.S.D.

N68-19379*# Boeing Co., Seattle, Wash. Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena. Aerospace Group.
LARGE AREA SOLAR ARRAY Quarterly Report
J. W. Ketchum, Frank W. McAfee, James L. Apperson, and D. A. Norsen Mar. 1968 208 p Prepared for JPL
(Contracts NAS7-100; JPL-951934)
(NASA-CR-93673; D2-113355-5) CFSTI: HC $3.00/MF $0.65 CSCL 10A

This report covers the technical progress and status of the Large Area Solar Array (LASA) Phase II Development program. Included are: (1) the program schedule status, (2) the progress of the mechanisms development, (3) a detailed description of the manufacturing development of an 8- by 13-foot beryllium-structured subpanel using fiberglass substrate for supporting the solar cells, (4) the development progress in the design and construction of a simulated zero g depolyment fixture and a deployment model for testing, and (5) ground support equipment. Author

N68-19389*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
DESIGN, DEVELOPMENT AND DEMONSTRATION OF A WARM GAS DISTRIBUTION SYSTEM Quarterly Report, Period Ending 31 Dec. 1967
15 Jan. 1968 23 p Prepared for JPL
(Contracts NAS7-100; JPL-951988)
(NASA-CR-93661; Rept.-68SD4203) CFSTI: HC $3.00/MF $0.65 CSCL 21H

Progress during the second three month period of a program to design, develop, and demonstrate a warm gas distribution system for use with a hydrazine fueled gas generator to provide spacecraft attitude control torques is reported. Activity during this reporting period was concentrated in component manufacture and delivery, and in the manufacture of the system test structure. Author

N68-19392*# Thermo Electron Engineering Corp., Waltham, Mass.
HEAT PIPE THERMIONIC CONVERTER DEVELOPMENT Final Report, 23 Jun. 1966–6 Nov. 1967
P. Brosens Dec. 1967 115 p ref Prepared for JPL
(Contracts NAS7-100; JPL-951465)
(NASA-CR-93664; TE4067-61-68) CFSTI: HC $3.00/MF $0.65 CSCL 10A

Four heat pipe models, designated T/E-1 through T/E-4 were designed, fabricated, and subjected to a heat transfer test, a thermal cycling test, and a 100-hour run at maximum heat load. Model T/E-1 failed after the heat transfer test due to an embrittling reaction that occurred after assembly between the niobium heat pipe wall and its radiative coating. Model T/E-2 failed after the heat transfer test due to a faulty capilarry assembly which caused overheating and a failure at the heap pipe-collector junction. Model T/E-3, fabricated with an emitter structure and operated as a converter, yielded valuable data on converter radiator heat load for accurate heat pipe sizing. This model completed the thermal cycling test and a 400-hour run at maximum load. Model T/E-4, without an emitter structure, had a larger radiator area than the other models and could accommodate an output current of 71.5 amperes at the optimum collector temperature. The model completed all the tests successfully, resulting in a heat pipe collector-radiator suitable for incorporation in the advanced SET converter. R.N.A.

04 BIOSCIENCES

Includes aerospace medicine, exobiology, radiation effects on biological systems; physiological and psychological factors. For related information see also: 05 Biotechnology.

N68-18304# Weizmann Inst. of Science, Rehovoth (Israel).
INFLUENCE OF OXYGEN TOXICITY ON THE RATE OF RED CELL AGING Final Report
Dave Danon Wright-Patterson AFB, Ohio AMRL Sep. 1967 20 p refs
(Contract AF 61(052)-879)
(AMRL-TR-66-168; AD-664339)

The effect of oxygen toxicity on red cell aging was experimentally studied. The alterations in age distribution of red cells of rabbits submitted to a high oxygen concentration was determined by density distribution, osmotic fragility, acid fragility, and electron microscopy. Increased osmotic fragility and density of the red blood cells as well as an increased resistance to acid fragility is indicative of an increased population of structurally old cells. Red cell membranes as seen in the electron microscope present morphological features in agreement with this interpretation. Author (TAB)

N68-18340# RAND Corp., Santa Monica, Calif.
ACID-BASE METABOLISM AND THE PROTON CONDITION
C. D. Russell Dec. 1967 49 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5451-PR; AD-664038)

Application is made of the proton condition of inorganic chemistry to the problem of describing the net acid content in a biological system. A proton content is defined that expresses the net acid content in terms of the detailed chemical composition of the system. This approach is compared with previous approaches to the quantitative description of acid-base metabolism and is then applied to the interpretation of experimental metabolic balances. The principal advantage of the mathematical formalism described in this study is that its use pinpoints the assumptions and makes it possible to handle unusual cases simply by including terms that are normally neglected. Author (TAB)

N68-18375# Agricultural Research Service, Ithaca, N. Y. Soil and Water Conservation Research Div.
THE ENERGY BUDGET AT THE EARTH'S SURFACE: ASSESSING SOURCES AND SINKS OF CARBON DIOXIDE IN A CORN CROP USING A MOMENTUM BALANCE APPROACH Interim Report
E. R. Lemon and J. L. Wright Jul. 1967 26 p Prepared in cooperation with Cornell Univ.
(Cross Service Order 2-68)
(RR-398; ECOM 2-68I-1; AD-664227) CFSTI: HC $3.00/MF $0.65

A momentum balance was used to estimate the vertical diffusivity of bulk air in a corn canopy. Simultaneous measurements of mean CO2 profiles enabled an evaluation of the source and sink (respiration and photosynthesis) distribution in the corn canopy. From the later data and light distribution data photoefficiency and light response were evaluated. Author (TAB)

N68-18376# Agricultural Research Service, Ithaca, N. Y. Soil and Water Conservation Research Div.
THE ENERGY BUDGET AT THE EARTH'S SURFACE: ESTIMATES OF THE DIFFUSION RESISTANCE OF SOME LARGE SUNFLOWER LEAVES IN THE FIELD Interim Report
L. A. Hunt, Ivan I. Impens, and E. R. Lemon Aug. 1967 14 p refs Prepared in cooperation with Cornell Univ.
(Cross Service Order 2-67)
(RR-396; ECOM 2-67I-3; AD-664215) CFSTI: HC $3.00/MF $0.65

Studies of resistance to gaseous exchange between large sunflower leaves and the bulk air in a crop canopy were made. Two components of the diffusive pathway for mass and sensible heat were evaluated; (a) the resistance from the interior of the leaf to the leaf surface, and (b) the resistance from the surface of the leaf through the leaf boundary air layer to the bulk air. It was found that: (a) leaf resistance not only displays diurnal trends but shorter fluctuations, and (b) boundary air layer resistance was significantly smaller than predicted from classical boundary layer formulae. Author (TAB)

N68-18433# Army Dept., Washington, D. C.
THE POSSIBLE PARTICIPATION OF GROWTH STIMULANTS AND NUCLEIC ACIDS IN THE MECHANISM OF THE ACTION OF PHYTOCHROME [O BOZMOZHNOM UCHASTII ROSTOVYKH VESHCHESTV I NUKLEINOVYKH KISLOT V MEKHANIZME DEYSTVIYA FITOKHROMA]
M. B. Shternberg 22 Nov. 1967 48 p refs Transl. into ENGLISH from the book "Regulyatory Rosta Rasteniy i Nukleinovyy Obmen" Moscow, Nauka Publishing House, 1965 p 65–102
(NIC-TRANS-2317; AD-664021)

Of the three hypotheses on the mechanism of the action of phytochrome (by means of growth stimulants, by means of a common link in the metabolism, and by a system of regulation) the one which is apparently closest to the truth is the third one

which speaks of the action of light which has been absorbed by phytochrome through a system of regulation which includes active, specific DNA and RNA. In support of this concept it is now possible to cite not only information on the diversity, specificity, and genotypic dependence of the reactions of the plants and their individual organs on light and information concerning change of sensitivity to the action of light during the course of ontogenesis, but also the first data on the de novo synthesis of proteins and enzymes under the action of red light. In studying the possibilities for the transmission of external influences on some elements of the system of regulation and in seeking out these sensitive elements the use of phytochrome as the acceptor of light stimulation should play a significant role. Author (TAB)

N68-18512 Texas Univ., Austin.
A MATHEMATICAL MODEL FOR THE BIOLOGICAL CLOCK OF PASSER DOMESTICUS
Charles Glenn Richie (Ph.D. Thesis) 1967 142 p
Available from Univ. Microfilms: HC $6.80/MF $3.00 Order No. 67-8152

The work presented in this thesis is a novel application of modeling and nonlinear differential equation theory to the life sciences. The field of circadian rhythms is briefly discussed along with the use and need for a mathematical model of biological clocks. The general properties of oscillators are discussed, and the qualitative agreement between nonlinear oscillators and circadian rhythm data is demonstrated. The case of two coupled weakly nonlinear oscillators is treated in detail with particular emphasis on coupled Rayleigh oscillators. A method for obtaining approximations for the multifrequency solutions of two unforced weakly coupled weakly nonlinear oscillators is presented. An illustrative example of coupled Rayleigh oscillators is included. Author

N68-18513 Stanford Univ., Calif.
AN ELECTROKINEMATIC THEORY OF MUSCLE CONTRACTION
Neil Barton Ingels, Jr. (Ph.D. Thesis) 1967 109 p
Available from Univ. Microfilms: HC $5.40/MF $3.00 Order No. 67-7926

This theory proposes a mechanism by which the force of muscular contraction could be developed in striated muscles. The mechanism does not depend on a mechanochemical interaction of the actin and myosin filaments, but rather assumes that the F-actin filaments, neutrally charged at rest, assume a positive line charge during stimulation, and thus attract the negatively charged L-myosin filaments in the manner of an electrostatic solenoid. Calcium ions, released and later re-accumulated by the elements of the sarcoplasmic reticulum in response to muscle stimuli, are assumed to be responsible for these alterations in charge density on the actin filaments and thus regulate the magnitude and form of the forces developed in the sarcomere. By means of a mathematical model, the proposed contractile scheme is shown to agree with contemporary experimental evidence concerning isometric force development in striated muscles. Dissert. Abstr.

N68-18514 Texas Univ., Austin.
ENHANCEMENT OF PHOTOSYNTHESIS IN CHLORELLA AND A KINETIC MODEL FOR PHOTOSYNTHESIS
James Henry Eley, Jr. (Ph.D. Thesis) 1967 91 p
Available from Univ. Microfilms: HC $4.80/MF $3.00 Order No. 67-8100

We have examined photosynthesis rates in Chlorella on an oxygen electrode. Visible light of desired wavelength was obtained with two grating monochromators focused on the electrode and controlled as to on–off regime by electronic shutters. We have confirmed and extended experimental observations of superimposed enhancement, alternated enhancement and chromatic transients as to wavelength dependency. Short period ($\leq$1.2 sec) alternation of a light 1 and a light 2 balanced in intensity to give equal steady state rates of photosynthesis, show enhancement values approaching that for superimposed beams. At longer periods of alternation enhancement decays as an inverse function of the balanced rate and approaches 1.0 at alternation periods of 20 seconds or longer. Dissert. Abstr.

N68-18607# Johns Hopkins Univ., Baltimore, Md.
STUDIES ON BIOLUMINESCENCE AND ENERGY TRANSFER MECHANISMS
W. D. McElroy 15 Nov. 1967 13 p refs
(Contract AT(30-1)-2514)
(NYO-2514-9) CFSTI: HC $3.00/MF $0.65

Progress is reported on studies on identification of intermediates and products of the light reaction in firefly luminescence. Experiments were conducted to determine the fate of the substrate LH_2 the nature of the emitting species, and the function of the enzyme luciferase. Dehydroluciferin was synthesized, and peptides containing this substance were isolated and purified. NSA

N68-18695# Illinois Univ., Urbana. Dept. of Physics.
MOESSBAUER STUDIES OF THE IRON ATOM IN CYTOCHROME C
R. Cooke and P. Debrunner [1967] 24 p refs
(Contract N00014-67-A-0305-0005; Grant NIH GM-720)
(AD-664519)

Mossbauer spectra of the iron atom in horse heart cytochrome c were observed in frozen solution and freeze dried samples for both the oxidized and reduced states. At temperatures above 77K, the spectrum of the oxidized enzyme consisted of a quadrupole split doublet, broadened by a temperature dependent magnetic hyperfine interaction. The spectrum of the reduced enzyme consisted, at all temperatures observed, of two peaks with a quadrupole splitting of 0.12 cm/sec. Upon freeze drying the quadrupole splitting of the oxidized enzyme decreased, whereas the spectrum of the reduced enzyme changed very little. Author (TAB)

N68-18706*# Douglas Aircraft Co., Inc., Huntington Beach, Calif. Missile and Space Systems Div.
STUDY OF AN ANIMAL RESEARCH FACILITY (USING S-4B) FOR A MANNED ORBITAL BIOTECHNOLOGY LABORATORY Final Report
L. T. Kail Sep. 1967 189 p refs
(Contract NAS7-518)
(NASA-CR-93485; DAC-58039) CFSTI: HC $3.00/MF $0.65 CSCL 06S

The feasibility of using an orbiting Saturn S-4B workshop for a manned animal research laboratory was studied. The number and type of animals involved, the biological experiments to be carried out, and the crew tasks are outlined for alternate mission profiles. Based on these factors, alternate configurations, involving both multiple and single modular concepts, are presented. The supporting research and technology requirements are discussed, and specific design criteria and recommendations are presented for laboratory and supporting equipment. The life support system for both animals and human crew is considered in detail. E.J.S.

N68-18734# Nuclear Energy Information Center, Warsaw (Poland). Dept. of Radiobiology and Health Protection.
STABLE AND RADIOACTIVE LEAD IN ENVIRONMENT AND HUMAN BODY
Z. Jaworowski 1967 189 p refs
(NEIC-RR-29)

Studies were undertaken to determine the level of stable and radioactive lead in typical components of the biosphere and in the organism, as well as to examine their sources and temporal and geographical distribution. The abundance and isotopic composition of lead are discussed, and it is shown how the isotopic composition of stable lead may vary depending on its origin

Various methods of determining stable lead are reviewed, with details given on a wet ashing method. Several approaches used in determining radioactive lead are assessed, and the separation of bismuth-210 by cup ferron extraction and by internal electrolysis is described. The origins and levels of stable and radioactive lead in the environment are examined, and the difficulties involved in determining the existing and natural levels of lead in the body are discussed. Data are tabulated to show the temporal and geographical distribution of the leads in the environment. A reference bibliography is included. M.G.J.

N68-18737# Aerospace Medical Div. Aerospace Medical Research Labs. (6570th), Wright-Patterson AFB, Ohio.

THE HUMAN SPINAL COLUMN AND UPWARD EJECTION ACCELERATION: AN APPRAISAL OF BIODYNAMIC IMPLICATIONS Final Report, Jul. 1965–Jun. 1966

John H. Henzel Sep. 1967 57 p refs

(AMRL-TR-66-233; AD-664553)

Vertebral compression represents a significant percentage of the morbidity associated with upward ejection. Vertebral and intervertebral structure reacts to and is sometimes irreversibly altered by ejection acceleration. Design and material properties of the normal vertebral column are sufficiently constant that when structural characteristics are defined and acceleration profiles known, prediction of failure may be made. Compressive load analyses of vertebra-disc complexes demonstrated that the vertebral end-plates are the initially failing structures of the spinal column. From experimental data on vertebral breaking-loads, acceptably accurate probability-of-injury curves for static loading were generated. These data together with data describing the dynamic response characteristics of the human body permit calculation of the probability-of-injury for dynamic loading produced by exposure to impact accelerations. As an aid to the designer of ejection systems, application of these concepts should refine the estimate of safe acceleration profiles and minimize the risk of irreversible vertebral deformation. Author (TAB)

N68-18748*# Aerojet-General Corp., Dayton, Ohio. Toxic Hazards Research Unit.

INHALATION TOXICITY AND CHEMISTRY OF PYROLYSIS PRODUCTS OF BROMOTRIFLUOROMETHANE

E. H. Vernot *In* AFSC, Brooks AFB, Tex. Proc. of Fire Hazards and Extinguishment Conf. 23 May 1967 p 107–117 refs (See N68-18744 09-05)

Groups of rats were exposed in inhalation chambers to pyrolysis products of 1700 to 4500 ppm monobromotrifluoromethane in order to determine the formation of toxic materials during $CBrF_3$ decomposition at 800°C. Test data evaluation established a 2300 ppm $CBrF_3$ concentration equivalent to 50% mortality; animals surviving exposure suffered weight loss but recovered after about 14 days. Analyses of $CBrF_3$ pyrolysis products showed the presence of high HF concentrations. At the LC_{50} value of pyrolized $CBrF_3$ (2300 ppm), 2480 ppm HF was formed; thus, the toxicity of $CBrF_3$ pyrolysis was attributed to HF formation. G.G.

N68-18895# Atomic Energy of Canada, Ltd., Chalk River (Ontario). Div. of Biology and Health Physics.

AN INCREASED YIELD OF GAMMA INDUCED EYE COLOUR MUTATIONS FROM CHRONIC VERSUS ACUTE EXPOSURES IN *DAHLBOMINUS*

W. F. Baldwin Nov. 1967 17 p refs Presented at IAEA Symp. on use of Isotopes Radiation in Entomology, Vienna, 4–8 Dec. 1967

(AECL-2791) Available from Atomic Energy of Canada, Ltd., Chalk River: $0.50

The mutagenic effects of chronic and acute irradiations on the fecundity of *Dahlbomin* females were studied. Studies of the effects of 500 rads of gamma radiation delivered chronically over the period of comparable sensitivity, i.e. over 100 hours from 9 days to 13 days after the pupal stage, and of the same dose as acute exposures at different times in this period were completed, and complemented by similar studies using 250 rads. Results with 500 rads indicated an approximately 20% greater mutagenic effect of the chronic as compared with the acute exposures. Results at 250 rads showed that the difference in mutation frequency with acute as compared with chronic doses was less at this lower exposure, implying that the difference in effect was probably the result of a disproportionately greater killing by the acute irradiation of cells which would have produced mutations. Records of parasitization and the number of progeny per female following acute and chronic exposures at 500 and 250 rads gave conflicting results, indicating that differential killing may not be a factor in determining mutagenesis. Results are based on 923 eye colour mutations in a total of 346,171 flies scored. Author

N68-18906# Joint Publications Research Service, Washington, D. C.

SPACE BIOLOGY AND MEDICINE, VOLUME 1, NUMBER 6

14 Mar. 1968 141 p refs Transl. into ENGLISH of Kosmich. Biol. i Med. (Moscow), v. 1, no. 6, 1967 p 1–96

(JPRS-44732) CFSTI: HC $3.00/MF $0.65

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N68-18907# Joint Publications Research Service, Washington, D. C.

COOPERATION OF BIOLOGY, MEDICINE AND ENGINEERING IN SUPPORT OF MANNED SPACE FLIGHTS

B. A. Adamovich *In its* Space Biol. and Med., Vol. 1, No. 6 14 Mar. 1968 p 1–6 (See N68-18906 09-04)

This paper is a discussion of bioengineering problems of manned space flights, emphasizing the fact that they can be accomplished only on the basis of close cooperation among specialists in various fields of knowledge. Many biomedical problems associated with manned space flights necessitate joint efforts by experts in medicine, biology, chemistry and engineering. Author

N68-18908# Joint Publications Research Service, Washington, D. C.

CELL AND TISSUE CULTURES AS RESEARCH OBJECTS IN SPACE BIOLOGY AND MEDICINE

V. V. Portugalov, F. V. Sushkov, and V. B. Starikova *In its* Space Biol. and Med., Vol. 1, No. 6 14 Mar. 1968 p 7–23 refs (See N68-18906 09-04)

In order to evaluate the possibility of using cell cultures for biomass production in a closed ecological system, methods for cultivating mammalian cells in deep cultures are advocated. Surplus products of a closed ecological system such as vegetable proteins obtained from Chlorella or other unicellular algae, from cultures of microorganisms or from other sources are possible culture medium components as indicated by the results of using protein hydrolysate of leguminous plant seeds to maintain monolayer cell cultures in a state suitable for virological purposes. G.G.

N68-18909# Joint Publications Research Service, Washington, D. C.

SOME EFFECTS DEVELOPING DURING HYPOKINESIA (EXPERIMENTS ON MICE)

V. V. Portugalov, O. G. Gazenko, Ye. I. Il'ina-Kakuyeva, V. B. Malkin, T. V. Artyukhina et al *In its* Space Biol. and Med., Vol. 1, No. 6 14 Mar. 1968 p 24–34 refs (See N68-18906 09-04)

The effect of reduced motor activity (hypokinesia) on mice was studied during 30-day experiments by physiological, cytochemical, electron microscope and histological techniques. It was found that during the first days of hypokinesia most test animals exhibited stress reactions. In the course of further confinement this type of response became less marked. By the 15th day changes caused by hypokinesia itself (atrophy of skeletal muscles, etc.) were manifested. By the 30th day the changes were less distinct than during earlier stages in the experiment. Author

N68-18910# Joint Publications Research Service, Washington, D. C.

REGULATORY MECHANISMS OF ACCELERATION-INDUCED HYDRODYNAMIC SHIFTS (AN EXPERIMENTAL STUDY BASED ON A PHYSIOLOGICAL MODEL)

Ye. B. Shul'zhenko and T. V. Sebekina *In its* Space Biol. and Med., Vol. 1, No. 6 14 Mar. 1968 p 35–40 refs (See N68-18906 09-04)

This paper gives results of a comparative study of the effect of animal exposure to transverse accelerations, accompanied by functional occlusion of pulmonary tissue, using basic hemodynamic indices. The similarity in changes in the cardiovascular system in animals with intact and with denervated sinocarotidal zones in both cases helped in establishing the role of vascular reflexogenic zones in the mechanism of circulatory regulation. The pathogenetic similarity gives support to the idea that cardiovascular changes occurring during exposure to acceleration are the result of neuro-reflex effects from pulmonary artery receptors. Author

N68-18911# Joint Publications Research Service, Washington, D. C.

SOME DATA ON THE MECHANISM OF THE DISTURBED PERCEPTIVE FUNCTION OF THE CEREBELLUM DURING ACCELERATIONS

L. D. Klimovskaya and N. P. Smirnova *In its* Space Biol. and Med., Vol. 1, No. 6 14 Mar. 1968 p 41–48 refs (See N68-18906 09-04)

Inhibition of induced activity of the cerebellar cortex in white rats exposed for 4 minutes to transverse accelerations of 10 g is described. A similar effect can be brought about by a high-frequency stimulation of the brain stem reticular formation. In this case it can be significantly alleviated by aminazin, whereas in case of accelerations the treatment produces no effect. This indicates a rather complicated genesis of the inhibition of cerebellar activity induced during accelerations. In addition to the influence of the reticular formation, it may involve a direct access of excess afferent signals to the cerebellar cortex, hemodynamic changes and a physical effect of accelerations on nerve cells. Author

N68-18912# Joint Publications Research Service, Washington, D. C.

SOME ASPECTS OF ACETYLCHOLINE METABOLISM IN THE BRAIN AND HEART OF GUINEA PIGS EXPOSED TO ANGULAR ACCELERATIONS

N. V. Korneyeva and A. S. Ushakov *In its* Space Biol. and Med., Vol. 1, No. 6 14 Mar. 1968 p 49–54 ref (See N68-18906 09-04)

The acetylcholine content and cholinesterase activity in the brain and heart of guinea pigs exposed to angular acceleration of 1.5 g for 6 hours were investigated. The greatest changes were exhibited by bound acetylcholine. In both organs its content increased sharply in 10 minutes, decreased in 24 hours and reached normalcy 120 hours after exposure. Tests made at different times revealed a slight decrease of free acetylcholine in both organs with a return to normalcy 120 hours after exposure. The patterns of change of the general, acetylcholinesterase and pseudocholinesterase activities in the brain and heart tissues were different. The activity of these enzymes increased slightly in the brain tissues and decreased slightly in the heart tissues and returned to normalcy 120 hours after exposure. Author

N68-18913# Joint Publications Research Service, Washington, D. C.

EFFECT OF HYPOXIA ON FUNCTIONING OF THE VESTIBULAR ANALYZER IN RATS

I. I. Voinova *In its* Space Biol. and Med., Vol. 1, No. 6 14 Mar. 1968 p 55–60 refs (See N68-18906 09-04)

Data are presented on the dynamics of vestibular fluctuations in white rats in a low-pressure atmosphere (at altitudes of 11,000 and 12,000 m) occurring at a decompression rate of 2 and 25

m/sec. During the first hours of exposure the test animals exhibited an increase in the vestibulo-respiratory reflex and postrotary nystagmus. Vestibular fluctuations were more pronounced in animals exposed to altitude increase at the rate of 25 m/sec. Author

N68-18914# Joint Publications Research Service, Washington, D. C.

P^{32} INCORPORATION INTO BLOOD SERUM, LIVER AND BRAIN PROTEINS OF RATS IRRADIATED BY HIGH ENERGY PROTONS

R. D. Govorun and R. L. Orlyanskaya *In its* Space Biol. and Med., Vol. 1, No. 6 14 Mar. 1968 p 61–66 refs (See N68-18906 09-04)

Metabolic processes in rats were studied after their irradiation by 660-MeV protons. The exposure affected P^{32} incorporation into tissue proteins. It increased in the liver and brain and decreased in the blood serum. The most distinct changes were noted on the 6th and 20th days of the experiment. The incorporation returned to normal levels by the 30th day only in animals irradiated with a 300-rad dose. Author

N68-18915# Joint Publications Research Service, Washington, D. C.

A MATHEMATICAL MODEL OF CHLORELLA CULTIVATION PARAMETERS DURING EXPOSURE TO IONIZING RADIATION

I. S. Sakovich, I. V. Smirnov, V. A. Sakovich, and L. K. Vekshina *In its* Space Biol. and Med., Vol. 1, No. 6 14 Mar. 1968 p 67–72 refs (See N68-18906 09-04)

This paper describes a model which simulates the relationship between the division and growth rate of individual Chlorella cells and the growth rate of a batch-cultured biomass. The model allows one to apply the results of study of single radiation effects on cell division for an evaluation of chronic radiation effects on continuous Chlorella cultivation. Author

N68-18916# Joint Publications Research Service, Washington, D. C.

SOME DATA ON VOLATILE (OXYGEN CONTAINING) COMPOUNDS RELEASED BY VEGETABLES

V. P. Dadykin, L. N. Stepanov, and V. Ye. Ryzhkova *In its* Space Biol. and Med., Vol. 1, No. 6 14 Mar. 1968 p 73–79 refs (See N68-18906 09-04)

Development of closed bioengineering systems requires a proper knowledge of the quantity and composition of compounds released by plants. The gas chromatography method is used in determining the quantity of volatile oxygen-containing organic substances released by leaves of vegetables (radishes, beets, tomatoes, batatas, potatoes, carrots) and their roots (carrots, potatoes) when grown in a closed environment. Each species released volatile compounds of a specific composition. Tomatoes exhibited the maximal (14) number of peaks whereas potatoes and batatas had the minimum number (7), nine of which were identified. Some gases (acetaldehyde, acetone, propionic aldehyde, methanol, ethanol) were released by many plant species. Chromatograms of gaseous compounds released by leaves contained twice as many peaks as chromatograms for roots. Author

N68-18917# Joint Publications Research Service, Washington, D. C.

THE BIOLOGICAL VALUE OF UNICELLULAR ALGAE PROTEINS

N. S. Klyuskina and V. I. Fofanov *In its* Space Biol. and Med., Vol. 1, No. 6 14 Mar. 1968 p 80–85 refs (See N68-18906 09-04)

A study was made of the biological value of plant proteins (unicellular algae, soya). Weaned rats served as test animals. The biological value of algal proteins was found to be higher than that of soya proteins. Vitamin B_{12} given to animals on a soya diet did not improve theiry protein metabolism. Author

N68-18918# Joint Publications Research Service, Washington, D. C.

STUDY OF CHLORELLA CULTIVATION ON SOLUTIONS WITH MINERALIZED HUMAN WASTES

A. L. Agre, I. V. Aleksandrova, G. V. Ilgach, V. V. Krasnoshchekov, I. Ye. Ivanova et al *In its* Space Biol. and Med., Vol. 1, No. 6 14 Mar. 1968 p 86–90 refs (See N68-18906 09-04)

It has been shown that solutions obtained after mineralization of solid human wastes by the "wet" burning method can be used for intensive Chlorella cultivation. The solutions should have the toxic substances removed and be corrected in relation to proper mineral composition. Author

N68-18920# Joint Publications Research Service, Washington, D. C.

VARIATION IN OVERALL BODY TOLERANCE DURING A 62-DAY EXPOSURE TO HYPOKINESIA AND ACCELERATION

G. P. Mikhaylovskiy, N. N. Dobronravova, M. I. Kozar', M. M. Korotayev, N. I. Tsiganova et al *In its* Space Biol. and Med., Vol. 1, No. 6 14 Mar. 1968 p 101–108 refs (See N68-18906 09-04)

The overall tolerance of the human body was studied on six healthy male subjects during a 62-day period of hypokinesia. Beginning with the third week of the experiment the protective properties of the body deteriorated considerably (quantity of blood properdin, phagocytic activity of neutrophils, lysozymic activity of the saliva and bactericidal function of the skin). In addition to inhibition of natural immunity there was development of inflammatroy diseases, mostly affecting the mucous membranes and the vascular system. The results obtained should be taken into account in developing preventive measures for use during prolonged space missions. Author

N68-18921# Joint Publications Research Service, Washington, D. C.

EFFECT OF TRANSVERSE ACCELERATION ON SOME KIDNEY FUNCTIONS

M. M. Korotayev and A. I. Grigor'yev *In its* Space Biol. and Med., Vol. 1, No. 6 14 Mar. 1968 p 109–116 refs (See N68-18906 09-04)

The functional state of kidneys was determined for 40 test subjects after triple exposure to acceleration in the back-to-chest direction with a gradient increase of 0.2 g/sec up to 10 g for 20 seconds. Results of an urine sediment study revealed a statistically reliable ($P<0.001$) increase in erythrocyte numbers. Erythrocyte numbers and leukocyte numbers increased in urine samples both 4 hrs and 24 hrs after each exposure. It was concluded that hematuria following acceleration is associated with impaired renal blood circulation, increased permeability of vascular glomerule capillary walls, main membrane and inner lining of the capsule, and possibly with more severe capillary impairments G.G.

N68-18922# Joint Publications Research Service, Washington, D. C.

EFFECT OF FROLONGED BEDREST ON THE DYNAMICS OF CARDIAC CONTRACTIONS IN MAN

N. Ye. Panferova, V. A. Tishler, and T. G. Popova *In its* Space Biol. and Med., Vol. 1, No. 6 14 Mar. 1968 p 117–123 refs (See N68-18906 09-04)

Experiments with 5- to 20-day hypodynamia were conducted on 15 test subjects for studying their chronocardiometric dynamics with aid of polycardiographic techniques. The results obtained before and after the experiments were analyzed by variational statistics methods and compared. The hypodynamic effect was manifested in the myocardial hypodynamia syndrome, which included an increased tension period (at the expense of the asynchronous and isometric contractions phases), a decreased expulsion period, a reduced intrasystolic index, a decreased rate at which the intraventricular pressure increased and an increased index of

myocardial tension. These changes were accompanied by increased pulse rate, a decrease of systolic pressure, minute and stroke blood volumes, and increased diastolic pressure. Duration of general and mechanical systoles remained within normal limits. Possible mechanisms of the described processes are discussed. Author

N68-18923# Joint Publications Research Service, Washington, D. C.

THE EXPERIMENTER'S OBSERVATIONS AS A FACTOR IN SURDOCHAMBER TESTS

O. N. Kuznetsov *In its* Space Biol. and Med., Vol. 1, No. 6 14 Mar. 1968 p 124–130 refs (See N68-18906 09-04)

This paper describes psychophysiological peculiarities of disturbance-free solitude with outside observation as a factor in long-term surdochamber tests and some occupational situations. A study was made of a test subject who while being alone is aware that he is under continuous observation. The effect of outside observation is illustrated on the basis of behavioral reactions and reports of test subjects. The pattern and degree of their response to this observation reflects the psychological peculiarities of the individual. Immunity to outside observation is regarded as a special case of immunity to disturbances in general. The physiological effect of solitude with outside observation is considered in relation to dominant theory. Such solitude during surdochamber tests is regarded as a means for excluding the effect of the experimenter on a test subject. This method is more advantageous than other techniques for experimental investigation of the personality. Author

N68-18925# Joint Publications Research Service, Washington, D. C.

REVIEW OF PAPERS IN AEROSPACE MEDICINE FIELD

G. K. Mikushkin *In its* Space Biol. and Med., Vol. 1, No. 6 14 Mar. 1968 p 136–143 (See N68-18906 09-04)

Briefly reviewed are medical and biological support studies of aerospace interest. The effects of acceleration, vibration, noise, and modified environmental conditions on the human body, as well as psychophysiology and flight hygiene problems are discussed. G.G.

N68-18927*# National Aeronautics and Space Administration, Washington, D. C.

OXYGEN CONSUMPTION AND RESPIRATORY FUNCTIONS AT HIGH ALTITUDES [SAUERSTOFFAUFNAHME UND RESPIRATORISCHE FUNKTIONEN IN GROSSEN HOEHEN]

E. H. Christensen Dec. 1967 15 p Transl. into ENGLISH from Skand. Arch. Fuer Physiol. (Berlin), v. 76, 1937 p 88–100
(NASA-TT-F-11284) CFSTI: HC $3.00/MF $0.65 CSCL 06P

A study was made of the effect of high altitudes on oxygen intake during muscular activity and on respiration during rest and work. The results indicated that during work all subjects showed the same relationship between work intensity and O_2-intake at different altitudes. The degree of efficiency was not affected by the altitude. Lung ventilation was not reduced and increased strongly with increasing altitude, reaching a value of more than 120 liters/minute during work. Reduced lung ventilation was constant at identical O_2-intake at all altitudes investigated. At high heights, the alveolar O_2-tension was higher at work than at rest. At high altitudes, the maximum oxygen intake was limited by the ventilation of the lungs. Author

N68-18951*# Massachusetts Inst. of Tech., Cambridge. Man-Vehicle Control Lab.

BIOPHYSICAL EVALUATION OF THE HUMAN VESTIBULAR SYSTEM Semiannual Status Report

J. L. Meiry and L. R. Young Jun. 1967 22 p
(Grant NGR-22-009-156)
(NASA-CR-93544; MV-67-3; SASR-3) CFSTI: HC $3.00/MF $0.65 CSCL 06P

The physical properties of the vestibular system are examined to determine an analytical model of the canalicular response to rotation in a linear acceleration field. The distension of the membranous canal duct is shown to produce a "roller pump" action of the endolymph when the canal is rotated about an axis orthogonal to the linear acceleration vector. Experiments to evaluate further the apparently nonlinear low frequency response of the semicircular canals are presented and discussed. Author

N68-18954*# Northrop Space Labs., Hawthorne, Calif.

RELATIONSHIPS BETWEEN CELL POPULATION KINETICS AND RADIATION RESISTANCE IN POCKET MICE (HETEROMYIDAE: PEROGNATHUS)

J. J. Gambino and J. W. Towner 1966 10 p refs Presented at the 3d Intern. Congr. on Radiation Res., Cortina, Italy, 26 Jun.–2 Jul. 1966
(Contract NASw-812)
(NASA-CR-69454) CFSTI: HC $3.00/MF $0.65 CSCL 06R

Pocket mice (*Perognathus longimembris*), subjected to 1000 and 1500 rad whole body Co^{60} irradiation, were sacrificed in groups of 5 on days 1, 2, 5, 6, 7 post-irradiation. Degenerative changes were noted in the intestinal mucosa within hours after irradiation, but visible damage was confined mainly to intestinal crypts. Villi remained inteact throughout the observation period, but showed some reduction in size. Regeneration of mucosal epithelium was prompt, restoring villi to normal by the 7th day even after 1500 rad. Tritiated thmidine studies indicate that intestinal epithelium cells of pocket mice have a villus transit time of 5.7 days. This slow rate of villus attrition probably enhances post-irradiation survival, accounting, in part, for the high $LD_{50/30}$ (1500 r) reported for this species. Author

N68-18994*# Stanford Univ., Calif.

A FLUORESCENT PROBE AT THE ACTIVE SITE OF α CHYMOTRYPSIN

Richard P. Haugland and Lubert Stryer 21 Jan. 1967 40 p refs Presented at the Intern. Symp. on Conformation of Biopolymers, Madras Univ., 18–21 Jan. 1967
(Grant NGR-05-020-137)
(NASA-CR-78109) CFSTI: HC $3.00/MF $0.65 CSCL 06A

A highly fluorescent anthraniloyl group has been inserted at the active site of α-chymotrypsin. The anthraniloyl acyl enzyme is indefinitely stable at neutral pH, allowing a detailed spectrofluorimetric study of the mobility and polarity of the active site. The acylating reagent, p-nitrophenyl anthranilate, is very selective in its reactivity. Only one anthraniloyl chromophore is introduced into chymotrypsin, rendering the enzyme inactive. Chymotrypsinogen, diisopropylphosphoryl chymotrypsin, trypsinogen, lysozyme, and serum albumin do not react at all, while trypsin reacts slowly. Author

N68-19088# Kernforschungsanlage, Juelich (West Germany).

ANNUAL REPORT, 1966 [JAHRESBERICHT, 1966]

1966 212 p refs In GERMAN
(NP-17070)

The general development and organization of the Julich Nuclear Research Installation and the work of the Installation for the THTR Association are outlined. Data are presented from the Scientific Institutes of the Installation on the analysis of genetic, physiological, and biochemical bases of radioresistance, direct radiation effects on cells, organs, and complete organisms, prevention or inhibition of radiation injuries by treatment of plants and animals after irradiation, reversible damage in irradiated tissue cultures, analysis of radiation effects in irradiated chicken embryos, cytological basis research with respect to delayed radiation damage, agricultural chemistry, soil science, anatomy and physiology of house animals, development of an activation analytical method for the determination of resorbed elements with enriched stable isotopes, and investigation of element concentration in carcinomas, measurement of the trace element concentration in the blood and other samples as a function of the state of health. NSA

N68-19137*# Naval Submarine Medical Center, Groton, Conn. Physiological Sciences Div.

STUDIES OF CIRCADIAN CYCLES IN HUMAN SUBJECTS DURING PROLONGED ISOLATION IN A CONSTANT ENVIRONMENT USING EIGHT-CHANNEL TELEMETRY SYSTEMS

Bruce R. Clagg and Karl E. Schaefer [1966] 15 p refs Presented at Natl. Telemetry Conf., Boston, 10–12 May 1966

(NASA Order R-24)

(NASA-CR-74032) CFSTI: HC $3.00/MF $0.65 CSCL 06P

This report presents experiences obtained with the use of 8-channel telemetry systems in continuous simultaneous monitoring of six physiological functions (EEG, EKD, respiratory rate, body temperature, skin temperature, BSR) in one or two subjects during isolation experiments of two to three weeks duration. The studies were performed to determine the extent of internal desynchronization in free running circadian cycles of physiological functions, under conditions of confinement in a constant environment such as those encountered in spaceflights and underwater exploration. The enormous amount of one minute data obtained in these experiments required the development of special computer programs for the correction of artifacts in telemetered data and for the analysis of data to determine periodicities and phase shifts of circadian cycles. Author

N68-19214*# Kansas Univ., Lawrence. Engineering Science Div.

VEGETATION ANALYSIS WITH RADAR IMAGERY

S. A. Morain and D. S. Simonett 1966 21 p refs Presented at the 4th Symp. on Remote Sensing of the Environ., Ann Arbor, Mich., 11–14 Apr. 1966

(Contract NSR-17-004-003)

(NASA-CR-75170; CRES-61-9) CFSTI: HC $3.00/MF $0.65 CSCL 02F

This paper presents vegetation maps prepared from radar imagery obtained over several climatic environments. The maps and imagery have been compared with each other to determine the types of information extractable. Conventional vegetation maps were employed to aid in the comparison. Emphasis was on the K-band and AN/APQ-56 radar systems. Results indicate that it is normally possible, by means of tonal and textural comparisons combined with basic geographic knowledge of the study area, to: (1) prepare regional or reconnaissance vegetation maps either on the basis of physiognomy or vegetation "type"; (2) delimit vegetation zones as they vary with elevation; (3) trace burn patterns of previous forest fires; (4) delimit altitudinal timber line; and (5) identify species from inference in areas characterized by near monospecific stands. Author

N68-19222*# Chicago Univ., Ill. Dept. of Biophysics.

HIGH RESOLUTION ELECTRON MICROSCOPY OF BIOLOGICAL SPECIMENS

H. Fernandez-Moran [1966] 8 p refs Presented at 6th Intern. Cong. for Electron Microscopy, Kyoto, 27 Aug.–4 Sep. 1966

(Grant NsG-441)

(NASA-CR-76632) CFSTI: HC $3.00/MF $0.65 CSCL 06C

Improved instrumentation and specimen preparation techniques are briefly described for ultrastructural studies of biological systems with high resolution electron microscopy. Summary data are presented on improved point cathode sources with single crystal filaments and new types of molybdenum gun design; on short focal length objective lenses of improved stability; and on the precise alignment of multi-hole or annular condenser apertures and objective phase plates of composite ultrathin single crystal films with adjustable electric fields, or ferromagnetic thin film apertures permitting phase shift control. Improved specimen preparation techniques discussed include: systematic use of ultrathin carbon films prepared by evaporation in ultrahigh vacuum (10^{-8} torr) on special supports; asbestos filaments or related substrates for mounting specimens without background support; examination of wet or hydrated biological specimens in special vacuum tight microchambers, using low intensity microbeam illumination and cryogenic devices to minimize desiccation and radiation damage; and the examination of thin, frozen sections of native, unfixed tissue directly after ultrathin sectioning with a diamond knife, in microtomes operating in liquid nitrogen or helium cryostats, and transferred without thawing to the low temperature electron microscopy stage. E.J.S.

N68-19295*# Naval School of Aviation Medicine, Pensacola, Fla.

VISUAL HORIZONTAL PERCEPTION IN RELATION TO OTOLITH FUNCTION

Earl F. Miller, Alfred R. Fregly, and Ashton Graybiel Dec. 1966 14 p refs

(NASA Order R-93)

(NASA-CR-93657; NAMI-989) CFSTI: HC $3.00/MF $0.65 CSCL 06S

To determine the influence of the otolith organs on visually perceived direction of space the constant and variable errors of normal persons and deaf persons with bilateral labyrinthine defects during nineteen positions of body tilt within ±90° of gravitational vertical were compared. The general perceptual pattern was similar for the two groups, although that of the labyrinthine-defective group was found to be more variable, and greater E- and A-effects were manifested during several of the tilt positions. A significantly larger E-effect was observed in those subjects (L-Ds) with little or no ocular counterroll. Author

N68-19322*# Syracuse Univ., N. Y. Dept. of Bacteriology and Botany.

STUDIES ON TRACE ELEMENTS IN THE SPORULATION OF BACTERIA AND THE GERMINATION OF BACTERIAL SPORES Final Report, Jun. 1964–Dec. 1967

Ralph A. Slepecky Dec. 1967 9 p

(Grant NsG-693)

(NASA-CR-93684) CFSTI: HC $3.00/MF $0.65 CSCL 06M

To determine the relative binding of metals in the *B. megaterium* spores, spore supernatants were examined after each stage during a sequence of treatments: suspension in deionized water for 10 days; 0.02M ethylenediamine tetraacetic acid (EDTA), pH 5.2 for 2 hours; and acidification to pH 2.5 for 2 hours, to pH 1.75 for 2 hours, and to pH 1.30 for two hours. The results indicate that each of the metals analyzed has a characteristic pattern of elution from the intact spore. Based upon their ease of removal from the spores and their distribution in the eluted fractions, the eight metals are grouped as follows: (1) loosely bound, eluted from spores during storage in distilled water (K, Na, Zn, and perhaps Mg); (2) removed by a chelator of divalent cations, EDTA (Fe, Zn, and Mg); (3) replaced by moderate acidification in the range of pH 2.5 to 1.3 (Ca and Mn); (4) tightly bound, found in the residual spore material after acidification (Fe and Ca); and (5) distributed in several fractions, possibly indicating multiple locations or roles in the spore (Mg and Mn). M.G.J.

N68-19335*# Oregon State Univ., Corvallis.

SYSTEMATIC DESCRIPTION AND KEY TO ISOLANTS FROM LITTLE LAKE VOLCANIC AREA, CALIFORNIA Progress Report

W. B. Bollen, Fred Au, and Karen M. Byers 1 Dec. 1967 30 p refs Prepared for JPL

(Contracts NAS7-100; JPL-950783)

(NASA-CR-93671) CFSTI: HC $3.00/MF $0.65 CSCL 06M

Descriptive charts are given on 19 bacteria isolated from soils of the Little Lake Volcanic area in California. Of the bacteria described, 50.0% are species of the genus Bacillus, 42.9% are soil diphtheroids, and 7.1% are species of Micrococcus. The charts listed contain the staining, morphological, cultural and physiological characteristics of each type bacteria. B.S.D.

N68-19365# Oak Ridge National Lab., Tenn.
RADIATION BIOLOGY
5 Aug. 1965 63 p refs Proc. of Conf held Oak Ridge, Tenn., 2–5 Aug. 1965
(CONF-65087) CFSTI: HC $3.00/MF $0.65

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3. RADIATION EFFECTS AT THE CELLULAR LEVEL J. G. Brewen p 17–23 ref (See N68-19368 09-04)

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5. RADIATION EFFECTS IN PLANTS A. H. Haber p 37–47 (See N68-19370 09-04)

N68-19366# Argonne National Lab., Ill.
RADIATION IN RELATION TO BASIC BIOLOGY
M. R. Zelle *In* Oak Ridge Natl. Lab. Radiation Biol. 5 Aug. 1965 p 1–8 refs (See N68-19365 09-04)

The major objectives of this conference include a survey of fundamental principles and current developments of radiation biology and a consideration of the proper place of radiation biology in undergraduate curricula. It seemed appropriate, therefore, to review briefly some of the major contributions to basic biology resulting from the utilization of radiation in biological research. Obviously, in a short discussion, no pretense at completeness can be made; instead, rather arbitrary choices must be made. Further, these choices were not limited strictly to radiation biology but include many from other applications of radiation such as photobiology and use of radioactive tracers. Since as the student advances through high school, undergraduate, and graduate work, he progresses from the general consideration of the subject to the increasingly advanced and specialized, it seemed of interest to examine a widely used introductory high school biology text, the BSCS green version. Only a relatively few references to radiation were found and these were not discussed in detail. Author

N68-19367# Atomic Energy Commission, Oak Ridge, Tenn.
RADIATION BIOLOGY AS A SCIENCE
Walter D. Claus *In* Oak Ridge Natl. Lab. Radiation Biol. 5 Aug. 1965 p 9–15 (See N68-19365 09-04)

The theme is developed that radiation biology is not something apart from biology in general. It is biology. It is the whole of biology, looked at from the viewpoint of what radiation can do to living systems, and how it does it. No claim is made that this idea of viewing biology through the framework of radiation biology is a unique approach. It is somewhat similar to looking at biological organization through the integrating concepts of energy flow through the system, or of ecology and evolution. Author

N68-19368# Oak Ridge National Lab., Tenn.
RADIATION EFFECTS AT THE CELLULAR LEVEL
J. G. Brewen *In its* Radiation Biol. 5 Aug. 1965 p 17–23 refs (See N68-19365 09-04)

The first fact that must be established is what cellular structure is the primary target of the radiation. Although there is no clear one-to-one correlation between survival and the production of measurable nuclear damage, the majority of evidence indicates that cellular death is the result of nuclear damage. There are experiments on higher organisms that provide striking evidence that the nucleus is the primary target of radiation. Author

N68-19369# Oak Ridge National Lab., Tenn.
RADIATION EFFECTS IN MAMMALIAN TISSUES
Arthur C. Upton *In its* Radiation Biol. 5 Aug. 1965 p 25–35 (See N68-19365 09-04)

Case histories, chosen mainly from early workers in the field of radiation, are presented to illustrate the effects of radiation on the skin and other organs. The radiosensitivity of cells is examined, and the biological effects of various radiation levels are described for human and animal subjects. It is shown that irradiation interferes with the ability of cells to divide, but not necessarily to metabolize. Indications of cells repairing radiation damage are reported. E.J.S.

N68-19370# Oak Ridge National Lab., Tenn.
RADIATION EFFECTS IN PLANTS
Alan H. Haber *In its* Radiation Biology 5 Aug. 1965 p 37–47 (See N68-19365 09-04)

The prediction of radiosensitivity in various plant types is reviewed. The use of ionized particles to probe biological structures is examined, and the difference in effects seen when charged particles are substituted for electromagnetic radiation is described. Techniques are presented for the radiation-induced spin resonance investigation of dry materials, such as seeds. These techniques, combining radiation biophysics in the dry state and chemical treatments requiring hydration followed by redrying, provide a system for studying the effects of radical decay. The use of radiation as an inhibitor of mitosis, and its relevance to teaching botany in the undergraduate curriculum are discussed. E.J.S.

N68-19487*# National Aeronautics and Space Administration, Washington, D. C.
INFLUENCE OF EAST–WEST AND RETURN TRIPS ON THE CIRCADIAN RHYTHMS OF DIURESIS AND URINARY ELIMINATION OF SODIUM AND POTASSIUM [INFLUENCE DES VOYAGES AGRIENS EST–OUEST ET VICE VERSA SUR LES RYTHMES CIRCADIENS DE LA DIURESE ET DE L'ELIMINATION URINAIRE DU SODIUM ET DU POTASSIUM]
E. La Fontaine, J. Sirot, J. Pasquet, and J. Le Vernhe Mar. 1968 9 p refs Transl. into ENGLISH from Rev. de Med. Aeron. et Spatiale, v. 6, no. 23, 1967 p 11–15
(NASA-TT-F-11621) CFSTI: HC $3.00/MF $0.65 CSCL 06S

Diuresis and urinary elimination of sodium and potassium were measured for a group of 10 subjects by collecting 24-hour urine samples in six 4-hour segments, which allowed us to establish circadian oscillations of the eliminations (2/24 hour percentage in each specimen). Eight and two subjects were used in varying stopover and flight periods in Paris and Anchorage. Author

05 BIOTECHNOLOGY

Includes life support systems, human engineering; protective clothing and equipment; crew training and evaluation, and piloting. For related information see also: 04 Biosciences.

N68-18266# Army Medical Research Lab., Fort Knox, Ky. Experimental Psychology Div.
EFFECTS OF ATTENDING TO AUDITORY SIGNALS ON THE MAGNITUDE OF THE ACOUSTIC REFLEX Progress Report
Walter J. Gunn 25 Sep. 1967 33 p refs
(Rept.-751; AD-664133)

In order to test the hypothesis that the acoustic reflex (AR) is inhibited while subjects listen for faint signals or while they

track their threshold for a 250 Hz tone, two experiments were conducted in which the main objective was to measure the effects of attention demanding conditions on the magnitude of the AR. In the first of these, subjects were required to detect faint signals (threshold level clicks) in either phone ear or probe ear while the AR was elicited by a one second, 1500 Hz tone. The control condition consisted of merely remaining alert but not listening for a signal during the reflex elicitation. The results of this experiment did not demonstrate any significant effect of listening for faint clicks in either contralateral or homolateral ear on the magnitude of the AR. In the second experiment, subjects tracked a 250 Hz threshold level tone before and during eliciting tones of 15 seconds duration in the same ear. In the control condition, they merely remained alert during the elicitation. Results of this experiment showed the magnitude of the AR to be significantly ($p < .05$) larger when the subjects tracked the 250 Hz tone than when not tracking. These results do not support the notion of inhibition of the AR by subjects listening for faint sounds (Smith and Loeb, 1967). Author (TAB)

N68-18294# Boeing Co., Wichita, Kans.
SUBJECTIVE REACTION TO DUAL FREQUENCY VIBRATION
Stanley H. Brumaghim Dec. 1967 54 p refs
(Contract Nonr-2994(00))
(D3-7562; AD-664510) CFSTI: HC $3.00/MF $0.65

The purpose of the study was to provide information regarding subjective reaction to dual frequency vibration. Eight male volunteers rated Perceptible, Mildly Annoying, and Extremely Annoying levels of body resonant vibration (4, 5, 6, 8 and 10 cycles per second) under three conditions of background vibration. The background conditions were: (a) no background vibration, (b) 17 cycles per second (cps) vibration at 0.38 g, zero-to-peak, and (c) 17 cps vibration at 0.68 g, zero-to-peak. Under conditions of dual frequency vibration, subjects rated the effects of only the variable vibration frequencies and ignored the presence of the background vibration as much as possible. Vibration at each frequency was sinusoidal and in the vertical axis; subjects were seated. In general, subjective reaction curves obtained under no background vibration conditions were similar to those reported previously. Subjective thresholds to the variable frequencies at the Mildly Annoying and Extremely Annoying levels, were lowered as the severity of the background vibration was increased. The profiles of the subjective reaction curves were unchanged, in general, when ratings were made in the presence of the 0.38 g, 17 cps vibration. However, in the presence of the 0.68 g 17 cps background, Mildly Annoying subjective thresholds to vibration at the body resonant frequencies were inversely related to the difference between the primary and background frequencies. The Extremely Annoying subjective reaction curve again assumed the characteristic curvilinear profile. Subjects were highly consistent in making their ratings. Author (TAB)

N68-18298# Barry Wright Corp., Watertown, Mass. Controls Div.
RESEARCH ON ACTIVE VIBRATION ISOLATION TECHNIQUES FOR AIRCRAFT PILOT PROTECTION Final Report, Jun. 1965–Dec. 1966
Peter C. Calcaterra and Dale W. Schubert Wright-Patterson AFB, Ohio AMRL Oct. 1967 51 p refs
(Contract AF 33(615)-2955)
(AMRL-TR-67-138; AD-664090)

An investigation was conducted to evaluate the feasibility of protecting pilots from the vertical dynamic excitations experienced during low-altitude, high-speed (LAHS) flight by means of active isolation techniques. Performance specifications for candidate isolation systems were evolved based on definition of the expected dynamic environment, human tolerance levels, and cockpit clearance. Required vibration isolation and maximum relative displacement values were postulated. Analyses of existing isolation techniques indicated that, for the selected dynamic environment typically experienced during LAHS flights in the vertical direction (i.e., combined vibration and sustained acceleration excitations), passive systems cannot provide the required degree of vibration isolation while simultaneously limiting the maximum relative displacement to the desired values. Various active isolation techniques were evaluated. An active hydraulic system was selected, employing acceleration and displacement feedback mechanisms. Analyses were conducted to define the type of compensation and loop gains required to provide the desired isolation, limit the dynamic deflection, and maintain system stability. A laboratory model for experimental research was designed and tested. Test results show that the developed active hydraulic isolation technique provides the vertical isolation and displacement control postulated to be required for pilot protection during LAHS flight. In addition, the system exhibits zero static deflection, and is essentially insensitive to forces applied at the isolated payload, and to human-body resonance coupling effects. Author (TAB)

N68-18329# Bolt, Beranek, and Newman, Inc., Van Nuys, Calif.
THE EFFECTS OF BACKGROUND NOISE UPON PERCEIVED NOISINESS
David C. Nagel, John E. Parnell, and Hugh J. Parry Dec. 1967 61 p refs
(Contract FA-65-WA-1180)
(FAA-DS-67-22; AD-663902)

Cross modality tests, in which subjects matched the apparent intensity of a 100 Hz vibration applied to the fingertip to the noisiness of one-third octave bands of noise with center frequencies of 125 Hz, 1000 Hz and 4000 Hz, have been conducted to measure the effects of background noise upon the judged noisiness of the bands of noise. The tests have indicated that the growth function for noisiness behaves somewhat like a modified power function of the form psi = k (I to the n power - (I sub o) to the n power) where psi is noisiness, I is the intensity of the stimulus, Io is the threshold intensity for the stimulus in a given background noise and k and n are constants which depend upon the frequency of the stimulus noise band. On the basis of the results of the cross modality tests, a calculation scheme has been developed to account for the effects of background noise in the perceived noise level calculation. The calculation procedure reduces, differentially, the sound pressure level of each third octave band of the judged noise by an amount dependent upon the signal-noise-to-background-noise ratio in that frequency band. For signal-noise-to-background-noise ratios of greater than 65 dB, the band correction is equal to zero. However, preliminary calculations have shown that for realistic background spectra and signal-noise-to-background-noise ratios of 40 dB, the effect upon the perceived noise level of a judged noise, as predicted by the calculation scheme, is approximately 3 PNdB. Author (TAB)

N68-18405# Aerospace Medical Div. Aerospace Medical Research Labs. (6570th), Wright-Patterson AFB, Ohio.
MICROBIOLOGICAL CRITERIA FOR AEROSPACE POTABLE WATER SYSTEMS Final Report, Feb. 1964–Mar. 1965
Sheldon A. London and Arselus West Sep. 1967 18 p refs
(AMRL-TR-67-37; AD-664070)

Extended space missions will necessitate that life support subsystems operate on a closed ecological or bioregenerating principle. This entails a continual recycling or regeneration of materials to sustain space crews. Potable water may be made available by a variety of techniques from various sources, such as urine and atmospheric condensate. Microbiological potability standards that can realistically be applied to space water supplies are dictated by the inherent technological problems and logistic limitations. With these in mind, a standard of sterility is proposed and the reasons for this stringent requirement are indicated. For ground based studies, a less stringent standard is also compatible with equipment capabilities and experimental requirements. Author (TAB)

N68-18406# Duke Univ., Durham, N. C.
BASES AND CONSEQUENCES OF SYSTEMS OF COMMUNICATION Final Report, 1 Mar. 1960–30 Nov. 1967
Kurt W. Back 30 Nov. 1967 21 p
(Contract Nonr-1181(11))
(AD-664256)

A series of studies has been undertaken since 1960 specifically dealing with the bases and consequences of systems of communication. This final report summarizes those studies completed under the following three categories: (A) the study of personal relations and communication processes within a group structure (Communication and Group Interaction Studies), (B) physiological and psychological conditions of conformity (Socio-biology Studies), and (C) methods of social research (Methodology Studies). Author (TAB)

N68-18428# Battelle Memorial Inst., Columbus, Ohio.
WATER-ELECTROLYSIS CELLS USING HYDROGEN-DIFFUSION CATHODES Final Report, 1 Jun. 1965–20 Jan. 1967
Edwin S. Kolic and John E. Clifford Wright-Patterson AFB, Ohio AMRL Nov. 1967 43 p refs
(Contract AF 33(615)-2954)
(AMRL-TR-67-65; AD-664361)

The feasibility of extended operation of palladium-silver alloy hydrogen-diffusion cathodes was demonstrated by essentially 100 percent hydrogen transmission for 486 days of operation at the following experimental conditions: 6.35-mm-OD x 0.013-mm-wall Pd-25Ag cathode tube at 37 ma/sq cm; free electrolyte cell with 22 ml of 60 percent NaOH at 145C; cell voltage of 1.74 +0.03 or -0.03 volts with solid cylindrical platinum anode. The determination of the maximum efficient current density (MECD) as a function of temperature indicated that satisfactory operation in the above run could have been obtained at temperatures as low as 112C; 53C with new cathode-activation treatments; or 30C with rhodium treatment of the cathode. In addition to platinum, platinum-10 rhodium alloy was shown to be a satisfactory anode material, but not gold. The feasibility of producing hydrogen gas at a pressure 15 psi higher than oxygen with only a slight decrease in MECD was demonstrated. New electrolyte preelectrolysis procedures were developed to counteract apparent purity variations in reagent-grade NaOH pellets. Of a number of possible matrix materials investigated, the longest satisfactory operation was obtained with fuel-cell asbestos: 280 hours at 70C and 37 ma/sq cm, but only 15 hours at 135C. The feasibility of using a free electrolyte of phosphoric acid was demonstrated in a 4-hour run at 37 ma/sq cm and 60C. Author (TAB)

N68-18468# Operations Research Inc., Silver Spring, Md.
HUMAN RELIABILITY RESEARCH Final Report, May 1966–Aug. 1967
Charles Beek, Kenneth Haynam, and Gabriel Markisohn Sep. 1967 40 p refs
(Contract Nonr-4451(00))
(PRR-67-2; TR-430; AD-664495)

The research effort focused on two major areas, a survey and analysis of existing failure reporting systems, and the investigation of alternative indirect approaches to determining human performance and quantifying the human reliability contribution to weapon system effectiveness. It was found that existing failure reporting systems do not yield meaningful data on human-initiated malfunctions. In most cases, a strong reluctance to report all failures was noted, particularly human errors. In attempting to develop an indirect approach to human reliability analysis, two techniques were investigated, both of which rely on equipment failure reporting rather than human error reporting. One technique is ERUPT. This approach, by grouping the components of a weapon system into elementary reliability units, provides a means of inferring two human performance parameters from available equipment reliability and maintenance data. The second approach relates certain personnel characteristics of individuals operating and maintaining the equipment to number of failures and equipment repair times by the application of multivariate correlation analysis techniques. Author (TAB)

N68-18477# Thiokol Chemical Corp., Marshall, Tex.
TESTING "NOMEX" MATERIAL AS HEAT RESISTANT CLOTHING FOR INDUSTRIAL APPLICATION
Jul. 1967 44 p refs
(Contract DA-11-173-AMC-200(A))
(LD-17-67; AD-664122)

The objective of this series of tests was to determine the best combination of protective clothing (utilizing Nomex material) that would afford the line worker optimum protection against incident conditions. The data was recorded and developed for a period of time up to fourteen seconds. The first three to five seconds, however, are the most critical. Author (TAB)

N68-18497*# Naval School of Aviation Medicine, Pensacola, Fla.
INSTRUMENTATION FOR THE CORIOLIS ACCELERATION PLATFORM
W. Carroll Hixson 6 Nov. 1967 25 p refs Prepared jointly with NASA
(NASA Order R-93)
(NASA-CR-93432; NAMI-1022) CFSTI: HC $3.00/MF $0.65 CSCL 06B

The report describes a general-purpose instrumentation system developed for use in conjunction with the Coriolis Acceleration Platform, a combined linear and angular motion device recently installed at the vestibular research facilities of this activity. The system, based on the use of standard commercially available equipment, provides the basic transducers, signal-conditioning circuitry, and recording instruments required for the acquisition, display, and storage of a wide variety of commonly collected biological and bioenvironmental measurement data. Author

N68-18619# Army Aeromedical Research Unit, Fort Rucker, Ala.
ANALOG NYSTAGMUS ANALYZER
George W. Beeler, Jr. Dec. 1967 18 p
(USAARU-68-4; AD-664129) CFSTI: HC $3.00/MF $0.65

Rapid to-and-fro movements of the eye are classified as nystagmus. This movement is usually the consequence of reflex excitation of the extra ocular muscles associated with stimulation of the semicircular canals. An analog nystagmus analyzer is described that can produce continuous information concerning the duration, amplitude and slow-phase velocity of each nystagmic beat during experiments involving the vestibular apparatus. Author (TAB)

N68-18729# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md. Space Life Sciences.
ENVIRONMENTAL AND MOBILITY CONSTRAINTS ON THE CONFIGURATION OF A NONANTHROPOMORPHIC SPACE SUIT
J. A. Lieske and P. Iribe [1966] 9 p Presented at the Natl. Conf. on Space Maintenance and Extravehicular Activities, Orlando, Fla., 1–3 Mar. 1966

The orbital missions contemplated for the 1968–1980 period indicate that an extravehicular astronaut will require all the mobility and dexterity that the best soft suit can provide. In addition, he requires more life support, power, and other working aids than such a suit can carry. Design concepts are presented in the form of a large work pack or platform which meet these requirements. The astronaut can work from within or at a distance on an umbilical. Author

N68-18744# Air Force Systems Command, Brooks AFB, Tex. Aerospace Medical Div.
PROCEEDINGS OF FIRE HAZARDS AND EXTINGUISHMENT CONFERENCE

23 May 1967 209 p refs Conf. held at Brooks AFB, Tex., 23 May 1967
(AMD-TR-67-2; AD-664584) CFSTI: HC $3.00/MF $0.65

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N68-18745# Air Force Systems Command, Brooks AFB, Tex. Aerospace Medical Div.

TWO MAN SPACE ENVIRONMENT SIMULATOR ACCIDENT

A. G. Swan *In its* Proc. of Fire Hazards and Extinguishment Conf. 23 May 1967 p 4–38 (See N68-18744 09-05)

Described are the results of an investigation into a two man space environment simulator accident where the oxygen atmosphere ignited during a high altitude simulation study. Analyses of the residue and material inside the burned chamber established electrical arcing from a Teflon insulated electrical wire as the cause of the fire. It was assumed that one of the animal attendants accidently stepped on a lamp cord, fractured the insulation, and shorted it to the aluminum floor plate. G.G.

N68-18746# Air Force Systems Command, Wright-Patterson AFB, Ohio. Fuels, Lubrication and Hazards Branch.

FIRE PROTECTION FOR OXYGEN ENRICHED ATMOSPHERE APPLICATIONS

B. P. Botteri *In* AFSC, Brooks AFB, Tex. Proc. of Fire Hazards and Extinguishment Conf. 23 May 1967 p 39–69 refs (See N68-18744 09-05)

Materials, methods, and techniques to minimize the likelihood of fire initiation and enhance the probability for personnel survival in the event of fire in oxygen enriched atmospheres are evaluated. Effective fire protection requires: (1) elimination of all ignition sources; (2) minimization of combustibles with exclusion of flammable liquids and gases; (3) control of type, quantity, and arrangement of necessary combustible materials in the chamber; (4) fire walls and other containment techniques to isolate potential high risk fire zones; and (5) a fixed fire extinguishing system that incorporates automatic initiation by flame and smoke detectors as well as manual initiation. G.G.

N68-18747# Air Force Systems Command, Brooks AFB, Tex. Aerospace Medical Div.

FIRE EXTINGUISHMENT AND PROTECTIVE CLOTHING EVALUATIONS

Donald I. Carter *In its* Proc. of Fire Hazards and Extinguishment Conf. 23 May 1967 p 70–105 refs (See N68-18744 09-05)

Evaluated were fire extinguishing systems for a hypobaric and a hyperbaric environment as well as protective clothing to determine the qualitative degree of fire protection provided by various fiberglass cloth formulations. Data from actual test chamber evaluations established a freon fire extinguishing system triggered by ultraviolet detectors as most promising. Uniform tests with knitted tight fitting fiberglass materials in greater than 98% oxygen at 380 Hg showed good protection from flash fires. G.G.

N68-18749# Naval Experimental Diving Unit, Washington, D. C.

A REVIEW OF THE NAVY CHAMBER FIRE SAFETY PROGRAM

John V. Harter *In* AFSC, Brooks AFB, Tex. Proc. of Fire Hazards and Extinguishment Conf. 23 May 1967 p 128–138 (See N68-18744 09-05)

In order to prevent the occurence of flash fires in hyperbaric diving units, a program was started to remove all sources of ignition and all flammable materials. A fiberglass mattress was installed in the chamber, the electrical system was updated, and fiberglass clothing was used for the divers in the chamber. The chamber operated in the lower partial pressures of oxygen and the diver is not transferred into an air background from water depths beyond 200 feet. G.G.

N68-18750# Veterans Administration, Washington, D. C.

HAZARDS ASSESSMENT AND PROTECTIVE CLOTHING REQUIREMENTS

Thomas E. Goonan *In* AFSC, Brooks AFB, Tex. Proc. of Fire Hazards and Extinguishment Conf. 23 May 1967 p 148–154 (See N68-18744 09-05)

The following measures are advocated to prevent fires: (1) utilization of a hyperbaric chamber with an outer lock and sprinkler protection inside and with one sprinkler line positioned on top of the chamber and one on each side at floor level to project upwards; (2) maintenance of a constant pressure differential between the pressure head and the chamber; (3) protective clothing consisting of not more than one tightly fitting layer; and (4) removal of all electrical equipment to outside the chamber whenever possible. Emphasis is placed on the maintenance of not more than 3 lbs partial oxygen pressure in the chamber atmosphere since the fire hazard increases proportionally if this limit is exceeded. G.G.

N68-18751# Royal Air Force, Farnborough (England). Inst. of Aviation Medicine.

FURTHER STUDIES ON THE PROBLEMS OF FIRE IN ARTIFICIAL GAS ENVIRONMENTS

D. M. Denison *In* AFSC, Brooks AFB, Tex. Proc. of Fire Hazards and Extinguishment Conf. 23 May 1967 p 155–167 refs (See N68-18744 09-05)

Experiments with clothing fires on a human scale showed that: (1) flash fires pass over the surface of clothing, propagate in the nap, and ignite the material at many points almost simultaneously; (2) some flame proofing treatments are able to prevent this nap propagation; (3) flash fires cannot pass underneath tight clothing; (4) ordinary water sprays cannot control such fires; and (5) water sprinkler systems work only when they obtain an evenly dense spray in all spatial dimensions and are automatically triggered. Since helium was more effective in suppressing nap fires it is advocated as the diluent additive for an oxygen atmosphere. G.G.

N68-18752*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.

FLAMMABILITY TEST METHODS AND PROTECTIVE CLOTHING DEVELOPMENT

Richard S. Johnston *In* AFSC, Brooks AFB, Tex. Proc. of Fire Hazards and Extinguishment Conf. 23 May 1967 p 168–189 (See N68-18744 09-05) CSCL 11E

The thermal barrier capability of protective garments is evaluated by a flame impingement tester and temperature versus time curves on candidate space suit materials are discussed.

Materials evaluated were beta fiber cloth, armalon, asbestos, kapton, metallic fabrics, and melds of asbestos, beta, and metallic fibers. A beta filament glass fabric is considered for outer layers of all protective garments; beta underwear shows no adverse dermatological effects and had good vapor transmission properties. Tests with a beta material garment established its nonflammability but it was found that it did not provide a sufficient thermal heat barrier for the skin. G.G.

N68-18883*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

WATER RECLAMATION AND CONSERVATION IN A CLOSED ECOLOGICAL SYSTEM

V. G. Collins and D. C. Popma [1966] 19 p Presented at the Ecol. Technol. Symp., Washington, D. C., 14–15 Feb. 1966

(NASA-TM-X-57247) CFSTI: HC $3.00/MF $0.65 CSCL 06K

Introductory data are presented on life support requirements for manned space missions. The necessity for water reclamation and conservation on missions of medium or long duration is discussed, and multifiltration, distillation, reverse osmosis, and electrodialysis techniques are briefly reviewed. The efficiency required for use in closed ecological systems is outlined in terms of launch weight water requirements per man. Design criteria, reflecting high reliability, low weight and power, elimination of expendables, and water recovery approaching 100% are recommended. E.J.S.

N68-18870*# National Aeronautics and Space Administration, Washington, D. C.

TELEOPERATORS AND HUMAN AUGMENTATION. AN AEC–NASA TECHNOLOGY SURVEY

Edwin G. Johnson and William R. Corliss Dec. 1967 273 p

(NASA-SP-5047) GPO: HC $1.00; CFSTI: MF $0.65 CSCL 05H

This book surveys general purpose, dexterous, cybernetic machines developed in the last 25 years, emphasizing the principal subsystems of contemporary designs of such teleoperators. The purpose of the work is to present the concepts and techniques of teleoperators now used in nuclear and aerospace work for possible adaptation in exploring the seas, increasing industrial productivity, and aiding physically handicapped persons. Covered are: (1) present and potential teleoperator applications; (2) subsystems and man–machine integration; (3) design principles of structure, control, actuator, and sensor subsystems; and (4) teleoperator terminal devices. A glossary and an extensive bibliography are included. K.W.

N68-18903*# Kollsman Instrument Corp., Syosset, N. Y. Electro-Optics Div.

STEREO TV ENHANCEMENT STUDY Final Technical Report

E. Hudson and G. Cupit Feb. 1968 10 p

(Contract NAS8-21201)

(NASA-CR-61594) CFSTI: HC $3.00/MF $0.65 CSCL 05H

Summary data are presented on the test apparatus and procedures used to determine the effectiveness of TV stereo versus nonstereo presentations with respect to the operation of a remotely controlled extraterrestrial vehicle. Particular attention is paid to the problem of operating in an environment with a poor signal to noise ratio between noise and picture. The results show: (1) No significant difference was noted between stereo and nonstereo presentations for good subjects when it comes to judging either size or distance of targets in pictorial representations. (2) Reasonable results can be attained by good subjects after training. Typical values might be on the order of 3 or 4 inches of error for targets in the size range of 4 to 40 inches, 15 feet in judging distance over ranges up to 200 feet, and errors of approximately 3 feet in judging distance between targets over ranges of from 2 to 20 feet. It is concluded that stereo is not worth the additional cost and weight penalties, except solely as a redundant or back-up system. M.G.J.

N68-18919# Joint Publications Research Service, Washington, D. C.

COMPUTING CONCENTRATIONS OF VARIOUS GASEOUS CONTAMINANTS IN SPACESHIP CABIN ATMOSPHERES

L. T. Bykov *In its* Space Biol. and Med., Vol. 1, No. 6 14 Mar. 1968 p 91–100 (See N68-18906 09-04)

This paper gives formulas, tables and diagrams for computing the required ventilation of spaceship cabins in accordance with the admissible concentrations of gaseous contaminants. The character of the equations makes it possible to compare ventilation systems operating at different performance levels. A differential equation can be used as the process equation when establishing automatic checking of various gaseous contaminants on spaceship cabins. Author

N68-18924# Joint Publications Research Service, Washington, D. C.

UNIVERSAL VESTIBULOMETRIC SEAT (UVS)

S. S. Markaryan, A. A. Matveyev, and I. V. Pavlov *In its* Space Biol. and Med., Vol. 1, No. 6 14 Mar. 1968 p 131–135 refs (See N68-18906 09-04)

Described is a vestibulometric seat for calibrated irritation studies on the human vestibular analyzer by angular and Coriolis accelerations. The seat has three independent electrical drives which provide rotation abut the vertical axis and tilting of the seat and head with the subject in a sitting or prone position. The positions of the seat back, foot rest, head rest, and elbow rests can be regulated in height and slope; slip rings with reliable wire shielding insure the simultaneous registration of 15 physiological parameters during seat rotation. G.G.

N68-19011*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

THE PROBLEMS OF MAN'S ADAPTATION TO THE LUNAR ENVIRONMENT

William Letko, Amos A. Spady, Jr., and Donald E. Hewes [1966] 29 p refs Presented at the Workshop on Hearing, Bioacoustics, and Biomech., Moffett Field, Calif., 25–27 Jan. 1966 Sponsored by NAS-NRC

(NASA-TM-X-57241) CFSTI: HC $3.00/MF $0.65 CSCL 06S

Effects of the reduced gravity of the lunar environment on man's general senses of equilibrium are considered along with his ability to orient himself and move about on the lunar surface. It appears that the otolith and proprioceptive sensors will be directly affected by gravity reduction, while vision and the semicircular canals will be relatively unaffected. Complete loss of two of the general sensors, especially if vision is involved, will not permit man to maintain his equilibrium; but it is felt that the reduced stimulation in a lunar environment will be manageable by men who are properly trained. Data obtained in a reduced-gravity simulator are presented. M.W.R.

N68-19145*# Kollsman Instrument Corp., Syosset, N. Y. Electro-Optics Div.

STEREO TV ENHANCEMENT STUDY Final Technical Report

E. Hudson and G. Cupit Feb. 1968 108 p refs

(Contract NAS8-21201)

(NASA-CR-61630) CFSTI: HC $3.00/MF $0.65 CSCL 05H

A program was conducted to evaluate the ability of individuals to judge size and distance of targets on a TV-type display with both stereo and non-stereo presentations at different S/N ratios. Its purpose was to determine the effectiveness of stereo TV presentations in allowing an operator to remotely control an extra-terrestrial vehicle. Sixty subjects, both male and female, were shown 72 photographs of a lunar-type terrain on a dual TV-type projection system. Twenty-four of these pictures were monocular presentations, 24 were stereo taken with a 4-inch inter-camera distance, and 24 were stereo taken with a 12-inch inter-camera distance. The camera-to-target distances ranged from 20 to 200 feet, and the target sizes ranged from 4 to 40 inches. The subtended

visual angles of the targets covered a range from 5 to 550 minutes of arc. The results were that for trained subjects there was no significant difference between either of the stereo presentations and the non-stereo presentation at any noise level. Accuracy in judging size and distance of targets was equally good with all noise conditions, but there was a diminution in the number of targets seen at higher noise levels. Author

N68-19165*# Serendipity Associates, Chatsworth, Calif.
A DESCRIPTIVE MODEL FOR DETERMINING OPTIMAL HUMAN PERFORMANCE IN SYSTEMS. VOLUME 3: AN APPROACH FOR DETERMINING THE OPTIMAL ROLE OF MAN AND ALLOCATION OF FUNCTIONS IN AN AEROSPACE SYSTEM
Harold E. Price and Barbara J. Tabachnick Washington NASA Mar. 1968 1204 p refs
(Contract NAS2-2955)
(NASA-CR-878) CFSTI: HC $3.00/MF $0.65 CSCL 05H

Conventions, sequence of activities, and research needs are considered in an effort to determine the role of man in space and the allocation of functions to men and machines in aerospace systems. The 11 conventions discussed include the local and remote segment, optimal manned design, man-rated performance, core performance, and roles of men in systems. Types and components of human performance, personnel support systems, man–machine comparisons, personnel products package, and automation are the other conventions implicit in a descriptive model for determining optimal human performance in aerospace systems. Activities are considered in terms of determining both the optimal role of man and the optimal allocation of function; and detailed data are appended on man–machine performance and crew support requirements. M.W.R.

N68-19176# Institute of Aviation Medicine, Toronto (Ontario).
AEROMEDICAL INCIDENTS AMONGST CANADIAN FORCES PILOTS: A SURVEY
J. R. Smiley Feb. 1967 24 p refs
(Rept.-67-RD-1)

A probability sample of 300 Canadian Forces pilots was used in a questionnaire survey regarding their experience with aeromedical incidents. Peripheral information was sought about drug usage, flying with hangovers, hemorrhoids, and the role of flight surgeons as seen by the pilots. From 224 returns (a 75% response) it was found that 97% of pilots had had at least some aeromedical incidents in flight. The predominant cause was vertigo and/or disorientation. This cause factor also predominated when related to incidents threatening the safety of the aircraft. Findings related to drug usage and hemorrhoids were negative. However, 60% of the pilots had flown at least a few times with hangovers. Flying with hangovers was found to be significantly associated with higher incidence of all types of aeromedical incident. About 40% of pilots failed to report any of their aeromedical experiences to the flight surgeon. More significantly, 70% of those having experienced hazardous incidents failed to report these specific incidents. Author

N68-19235* Massachusetts Inst. of Tech., Cambridge. Research Labs. of Electronics.
READING MACHINE STUDIES FOR SENSORY AIDS
Samuel J. Mason 29 Jul. 1966 7 p Presented at NEREM-66, Boston, 2–4 Nov. 1966
(Grant NsG-496; Contract DA-36-039-AMC-03200(E); Grants NSF GK-835; NIH G-MH-04737-06)
(NASA-CR-77888) CSCL 05H

An experimental integrated real-time reading machine system is discussed which has been developed for research on character recognition, special-purpose picture processing, tactile pattern perception, and auditory displays, including artificial speech. The system consists of an electronic print scanner, local special-purpose logic circuitry for scan control, a data link to the PDP-1 and TX-0 digital computers in an adjacent building, a typewriter and console for system control, and earphone and loudspeaker outputs. In its present form the system recognizes actual Roman bookprint at an error rate of less than one-half percent; it also produces an auditory "spelled-speech" output, thus constituting a possible progenitor of practical reading aids for the blind. K.W.

N68-19288 Royal Aircraft Establishment, Farnborough (England).
PERFORMANCE MEASUREMENT IN UNUSUAL ENVIRONMENTS
L. G. Innes and M. F. Allnutt Apr. 1967 19 p refs
(T-298)

This paper discusses the relevant factors in assessments of operator performance in unusual environments. A discussion is presented of the aspects of human behaviour which have been shown to change under specific environmental stress conditions, and at what degree of severity, suddenness and duration of the stress they have been shown to change significantly. The man himself influences the result of any investigation of this kind, to the extent that individual differences often overshadow all other effects. The influence of personality factors, motivation, emotional state, and training are discussed, with reference to the relevant theoretical systems. The task done by the operator is an important variable in the situation, since sensory, psychomotor, and mental functions are differentially effected by different environmental deviations. The methodological problems of adjustment of task difficulty to ensure maximum sensitivity are explored. The influences of various psychological stresses resulting from the physical situation of the experiment, and of the degree and complexity of the fidelity of environmental simulation used, are considered in relation to the generality of experimental findings. Author

N68-19298*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
STUDY FOR THE COLLECTION OF HUMAN ENGINEERING DATA FOR MAINTENANCE AND REPAIR OF ADVANCED SPACE SYSTEMS. VOLUME 1: SUMMARY TECHNICAL REPORT Final Study Report, 26 Aug. 1966–31 Dec. 1967
31 Dec. 1967 112 p
(Contract NAS8-18117)
(NASA-CR-61650; Doc.-67SD4441, V. 1) CFSTI: HC $3.00/MF $0.65 CSCL 05E

Requirements for eight specified experiments, identified as the type of data needed by design engineers, were defined in order to obtain a preliminary description of experimental protocol and procedures, a proposed listing of experiment equipment requirements, and an evaluative and comparative listing of estimated costs and schedules. Neutral buoyancy zero-g simulation procedures, equipment design techniques, underwater facilities and self-contained backpacks were among the experimental methods used. Summary details are presented on experiment 84A, designed to evaluate and quantify man's ability to generate impulsive and sustained forces under a variety of conditions which simulate various modes of restraint and accessibility, and on Experiment 1A, designed to determine the factors which influence man's ability to transport free masses in zero gravity. Particular consideration is given to the characteristics of the object to be transported, the method of transport, and the path to be traversed. Also reported is the development of a handbook on human engineering design data for reduced gravity conditions. M.G.J.

N68-19443 Royal Aircraft Establishment, Farnborough (England).
MENTAL PERFORMANCE IN MILD OXYGEN DEFICIENCY
L. G. Innes and M. F. Allnutt Jun. 1967 17 p refs
(R-409)

An experiment was conducted to determine the effects of a simulated 10,000 ft altitude on certain selected tests of mental ability over a 100 minute exposure period. The tests, which

covered a wide range of mental functioning, were administered to two groups of electronics apprentices, one performing the tests while breathing ambient air and the other while breathing a 15.4% oxygen in nitrogen mixture. The pre-exposure time for both groups prior to testing was 30 minutes. Differences between the groups were not large enough at any stage to reach significant levels of confidence by statistical analysis. However, there are consistent indications that the breathing of the low oxygen mixture caused longer times to understand new problems, and slower reaction times for most test items, although accuracy was not affected. R.N.A.

N68-19493*# General Electric Co., Philadelphia, Pa. Missile and Space Div.

STUDY FOR THE COLLECTION OF HUMAN ENGINEERING DATA FOR MAINTENANCE AND REPAIR OF ADVANCED SPACE SYSTEMS. VOLUME 2: DETAILED TECHNICAL REPORT Final Study Report

31 Dec. 1967 428 p

(Contract NAS8-18117)

(NASA-CR-61649; Doc.-67SD4441, V. 2) CFSTI: HC $3.00/MF $0.65 CSCL 05E

Experimental techniques and facilities used in neutral buoyancy simulation of zero gravity conditions encountered in space maintenance and repair are described. The experimental conditions consisted of eight types of restraint (including no restraint), three force receiver distances, three force receiver angles, and two handle orientations. Data on maximum impulse and sustained forces were obtained and tabulated for each of four subjects for each experimental condition. The variables investigated were: type of restraint, receiver angle, receiver distance, receiver orientation, force type and direction, subject size, and suit pressurization methods. A description is given of the instrumentation and data recording processes used. These were designed for computerized data reduction as well as for real time monitoring by the test director. The scaling laws used were developed for underwater simulation by defining the equations of motion in orbit or in a partial-g environment and underwater, in a condition of neutral or partial buoyancy, by setting the coefficients of like terms in the equations of motion in space and water equal to each other, and then solving for the model characteristics. E.J.S.

06 CHEMISTRY

Includes chemical analysis and identification (e.g., spectroscopy). For applications see: 17 Materials, Metallic; 18 Materials, Nonmetallic; and 27 Propellants.

N68-18262# Naval Air Development Center, Johnsville, Pa. Aero Materials Dept.

A RADIOCHEMICAL INVESTIGATION OF THE LEACHING OF CHROMIUM FROM CHEMICALLY CHROMATED ALUMINUM ALLOY SURFACES. PART 3: THE "UPTAKE" OF THE CHLORIDE ION INTO SUCH SURFACES

A. L. Glass 23 Aug. 1967 23 p refs

(NADC-MA-6702; AD-664485)

Radioactive tracer procedures are used to investigate the leaching characteristics of chromium dissolving from chromated aluminum surfaces to which an organic protective coating was applied during the aging process and which was removed prior to immersion in the salt solution. A radioactive tracer procedure is described to determine the chloride ion uptake by chromated aluminum surfaces when immersed in salt solutions. Data are presented showing the effects of film thickness, aging periods and time of immersion in salt solution on the solution of chromium from the chromated surfaces and on the uptake of chloride ions by these films. Author (TAB)

N68-18314# Massachusetts Inst. of Tech., Cambridge. Dept. of Metallurgy and Materials Science.

ADSORPTION AT THE RUTILE-SOLUTION INTERFACE: 1: THERMODYNAMIC AND EXPERIMENTAL STUDY

Yves G. Berube and Philip L. de Bruyn Jan. 1968 44 p refs

(Contract Nonr-1841(86))

(TR-3; AD-664507)

A detailed thermodynamic analysis of the double layer at the interface, simple inorganic oxide-aqueous solution, is presented with special emphasis on the assumptions normally made in relating experimental observation to theoretical treatment. An experimental study of the adsorption of potential-determining ions ($H(+)$, $OH(-)$) at the rutile ($TiO2$)/solution interface is reported. The point of zero charge (pzc) for $TiO2$ at room temperature was observed to lie at pH 6.0, independently of its crystalline modification, but was lowered to below pH 4 by heat treatment of the oxide prior to adsorption measurement. The pzc was also observed to approach the neutral point (1/2 pKw) with increasing temperature in the temperature range, 25C to 95C. A thermodynamic consideration of the transfer of cationic and anionic potential-determining species from the aqueous solution to the surface at the pzc allowed the difference in the standard entropy of transfer to be estimated from this information. Author (TAB)

N68-18370# Aerospace Corp., El Segundo, Calif. Materials Sciences Lab.

ELIMINATION OF DAMAGE TO METALLOGRAPH OBJECTIVE LENSES BY ETCHANTS CONTAINING HYDROFLUORIC ACID, FEBRUARY–APRIL 1967

James H. Richardson Nov. 1967 12 p refs

(Contract F04695-67-C-0158)

(TR-0158(3250-10)-10; SAMSO-TR-68-29; AD-664554)

A technique is described for eliminating the potential hazard to metallographic objectives from traces of hydrofluoric acid from etchants on specimens. Specimens are immersed for 1 hr in a solution containing ammonium pentaborate and are then rinsed and dried. This solution reacts with the acid to form a soluble and noncorrosive compound. No visible damage to metallorgraph lenses (i.e., etching) has been observed from the use of treated specimens. Author (TAB)

N68-18372# RAND Corp., Santa Monica, Calif.

CHEMIST, THE RAND CHEMICAL EQUILIBRIUM PROGRAM

E. C. De Land Dec. 1967 143 p refs

(Contract F44620-67-C-0045)

(RM-5404-PR; AD-664045) CFSTI: HC $3.00/MF $0.65

A detailed report on the structure and use of CHEMIST, a computer program designed to simulate complex chemical equilibria. The study was compiled in response to a growing demand for a reference manual to accompany and document the program. CHEMIST is a program for use by professionals not trained in computer programming. Communication with the program is in English, chemical, and FORTRAN languages. The computer code currently exists in FORTRAN IV for the IBM 7044. In its present form it occupies approximately 25,000 words for the principal part. Additional specialized subroutines not essential to the operation can increase space requirements. The program uses an iterative mathematical programming technique to determine the composition that minimizes the total free energy of a chemical system, subject to system constraints. A detailed program description with examples is given, along with the program subroutines. The References and Selected Bibliography comprise as complete a listing of the literature as is currently possible. This manual will be updated as the CHEMIST program evolves further. Author (TAB)

N68-18378# Naval Research Lab., Washington, D. C. Surface Chemistry Branch.

CHLOROPHENYLALKYL-SUBSTITUTED CARBOXYLIC ACIDS AND SILANES DESIGNED AS ADHESION PROMOTERS Interim Report

J. G. O'Rear, P. J. Sniegoski, and F. L. James 26 Dec. 1967 32 p refs
(NRL-6658; AD-664461) CFSTI: HC$3.00/MF$0.65

The six new carboxylic acids of this study feature a terminal p-chlorophenyl substituent, a polymethylene spacer, and either one or two carboxyl groups. The carboxyl groups may be replaced by -SiCl3 or -Si(OC2H5)3 groups. Such structures are designed to promote adhesion between a solid substrate and an organic resin by forming a monolayer strongly attached to the substrate and exposing a chlorophenyl outer surface which is easily wet by the resin. Multistep syntheses were carried out for the preparation of monocarboxylic acids p-ClC6H4(CH2)n-1CO2H, where n is 12, 14, 18, and 20, via Friedel-Crafts reactions and Wolff-Kishner reductions. Some also used a subsequent LiAlH4 reduction. Succinic and glutaric acids substituted in the alpha position by a p-ClC6H4(CH2)12-substituent were prepared through malonic ester syntheses. The acids were characterized by melting points, neutralization equivalents, and elemental assays. NMR spectra showed that the chlorine substitution is at least 95% para. Gas-liquid chromatography was used to assess the purity of both intermediates and products; most of the acids had purities exceeding 97.5%. Principal impurities were the unchlorinated analogs and lower homologs. The Friedel-Crafts method was employed to prepare p-ClC6H4(CH1)2SiCl3; this compound and its trimethoxy and triethoxy analogs were characterized by conventional criteria.
Author (TAB)

N68-18379# Naval Research Lab., Washington, D. C.
IDENTIFICATION OF FREE RADICALS IN THE PHOTODEGRADATION OF POLYSTYRENE AND ITS HOMOLOGS
R. F. Cozzens, R. B. Fox, and W. B. Moniz 6 Dec. 1967 27 p refs
(NRL-6653; AD-664472) CFSTI: HC$3.00/MF$0.65

The photolysis of polystyrene and poly(alpha-methylstyrene) was studied by electron-spin-resonance (ESR) techniques using highly concentrated, glassy solutions of the polymers near liquid-nitrogen temperature. Care was taken to ensure detection of the primary free-radical species. The use of poly(1-vinylnaphthalene) and polystyrene-2,3,4,5,6-d5 verified that the primary free radical is located on the polymer chain and not the ring. The ESR spectra obtained for both polystyrene and poly(alpha-methylstyrene) are consistent with -CH2-PrC(.)-CH2-(.). Interpretation of the observed spectra is made on the basis of the stereochemistry of the polymer chain.
Author (TAB)

N68-18389# Nuclear Research Associates, Inc., Long Island City, N. Y.
THEORETICAL STUDIES OF COMPLEXED TRANSITION METAL THERMOPHOTOCHROMIC SYSTEMS Final Report, 1 Apr. 1966–31 May 1967
Jerome Goodman, Stanley Grand, and Sarah Mook Dec. 1967 58 p refs
(Contract NOw-66-0516-c)
(NRA-861; AD-664497)

Studies of the heat - and light-induced darkening of copper bromide films and solutions (see AD-470 074 and AD-645 539) provided the following conclusions: Darkening occurred as a result of equilibrium shifts to give dark copper complexes and that darkening could be increased varying the solvent or bromide concentration; the darkening reaction is basically thermal. Solutions and films were prepared which darkened considerably on heating through equilibrium shifts without loss of solvent. Absorbances at 100C averaged over the visible spectrum were as much as six times those at room temperature. These systems should be usable in stable liquid or film laminations. Also investigated was the electrical actuation of films with direct current, dielectric heating, and induction heating. Full darkening in about 0.1 seconds was demonstrated, but the fastest intrinsic response time for electrical actuation was not measured. Studies were also made of the darkening of copper bromide - dimethyl sulfoxide complexes, and of the nature of the reflective surfaces formed on some copper bromide films during darkening.
Author (TAB)

N68-18393# Dayton Univ., Ohio.
FAR INFRARED SPECTRA OF SATURATED ALIPHATIC ESTERS Summary Technical Report, Sep. 1965–Jul. 1967
James E. Saunders Wright-Patterson AFB, Ohio AF Mater. Lab. Dec. 1967 52 p refs
(Contract AF 33(657)-8553)
(AFML-TR-67-288; AD-664583)

The infrared spectra of 89 saturated aliphatic (branched and straight chain) esters are reported for the region 350-50/cm and empirical correlations of the band frequencies are classified by the alcohol component. It is found that there is no consistent series of bands for all samples studied but within the individual classes, several areas of absorption are specified. This verifies that these vibrations are more sensitive to structural differences than the higher frequency characteristic group frequencies and are useful in the total identification of a given sample.
Author (TAB)

N68-18420# Massachusetts Inst. of Tech., Cambridge. Dept. of Metallurgy and Materials Science.
THE HEAT OF FORMATION OF THE COMPOUND $AuSb_2$ AND THE PARTIAL ENTHALPIES AND ENTHALPY INTERACTION COEFFICIENTS OF ANTIMONY AND GOLD IN LIQUID TIN
A. K. Jena and M. B. Bever 22 Jan. 1968 9 p refs
(Contract Nonr-3963(19))
(TR-6; AD-664489)

The heat of formation of the compound AuSb2 at 273K and the partial gramatomic enthalpy of antimony in liquid tin at 623K were measured. Values of the partial gram-atomic enthalpy of gold and the enthalpy interaction coefficients of gold and antimony in liquid tin were calculated from the heat effects on solution of mixtures of gold and antimony in liquid tin at 623K. For the interpretation of the behavior of antimony and gold in dilute solution in tin non-zero values are assigned to the energies of bonds between like solute atoms relative to the pure solute state.
Author (TAB)

N68-18423# Boeing Scientific Research Labs., Seattle, Wash. Polymer Lab.
BIS[4(1-METHYL-1,2-EPOXYETHYL)] DERIVATIVES OF PHENYL ETHER, 1,4-DIPHENOXYBENZENE, AND BIS(4-PHENOXYPHENYL) ETHER
Roy G. Neville and John W. Mahoney (North Am. Aviation, Inc., Los Angeles, Calif.) Oct. 1967 15 p refs Prepared jointly with North Am. Aviation, Inc., Los Angeles
(Contract AF 33(615)-2866)
(DI-82-0612; AD-664093)

The syntheses of three new alpha-methyl substituted bis(epoxyethyl) derivatives of phenyl ether, 1,4-diphenoxybenzene, and bis(4-phenoxyphenyl) ether are reported. Improved procedures for preparing 1,4-diphenoxybenzene and bis(4-phenoxyphenyl) ether by the Ullmann method are described. Infrared spectral data for the bis-epoxides and their precursors are given, as are some reactions of the bis-epoxides.
Author (TAB)

N68-18426# Naval Research Lab., Washington, D. C.
ELECTRON IMPACT STUDIES OF VOLATILE INORGANIC COMPOUNDS Interim Report
F. E. Saalfeld and M. V. McDowell 22 Nov. 1967 35 p refs
(NRL-6639; AD-664216)

The appearance potential of an ion is defined as the minimum energy of bombarding electrons required to produce that ion from a particular atom or molecule. This potential can be estimated from ionization-efficiency curves by various methods, such as the initial

break method, linear extrapolation method, critical slope method, extrapolated difference method, second derivative method, ratio extrapolation method, and energy compensation method. By the use of appearance-potential data obtained from the mass spectrometer, the bond energies and heats of formation of unstable inorganic materials can be determined. Although there are several possible sources of error in a mass spectrometric thermochemical determination, it is often the only method by which these important properties can be determined for many of the transient and highly reactive molecules and radicals. Where literature values were available, there was usually good agreement between the thermochemical values determined by mass spectrometric measurement and those found by other methods. Author (TAB)

N68-18434# Naval Research Lab., Washington, D. C.
ON THE ACTIVITY OF PLATINUM CATALYSTS IN SOLUTION. PART 1: EFFECTS OF THERMAL TREATMENT AND CHEMICAL ETCHING ON THE Pt-O/HYDROGEN SPECIFIC REACTION RATE
Theodore B. Warner, Sigmund Schuldiner, and Bernard J. Piersma 11 Dec. 1967 25 p refs
(NRL-6622; AD-664490)

The effects of thermal treatment and chemical etching of platinum on the specific rate of the chemical reaction of chemisorbed oxygen with hydrogen were determined. The hydrogen was present in electrochemically clean 1M H_2SO_4 and in the derma of the metal. On successive thermal treatments of bright Pt beads, which were heated to the melting point and then slowly recrystallized under high temperatures, the specific rate varied randomly from trial to trial. Where heating was more uniform and the cooling rate slower, reaction of hydrogen with Pt-O was usually faster. Repeated aqua regia etching of a given Pt bead caused monotonic improvement until a rate between 0.014 and 0.021 amp/sq cm was attained. Rates on Pt wire electrodes, which probably differed from the flame-formed Pt beads both in average crystallite size and number of defects (created by the drawing process and only partially removed by subsequent annealing), were highly variable but considerably lower than on beads. Surfaces whose activity for the Pt-O/hydrogen reaction differed manyfold showed no differences in anodic charging curves. Electrochemical rates of water oxidation at +0.617 v and +0.587 v (NHE) and reduction of hydrogen ions at +0.300 v also did not differ. It appears that many electrochemical reactions are insensitive to these differences in surface condition. Author (TAB)

N68-18459# Army Dept., Washington, D. C.
OXIDATION OF UNSATURATED COMPOUNDS WITH ORGANIC PEROXIDES [OKISLENIYE NEPREDEL'NYKH SOYEDINEIY ORGANICHESKIMI PEREKISYAMI]
N. Prilezhayev 20 Oct. 1967 44 p refs Transl. into ENGLISH from J. Russian Phys. Chem. Soc. (USSR), v. 42, 1910 p 1387–1418
(NIC-TRANS-2478; AD-664023)

Studies on the oxidation of n-octene, diisobutylene, decylene, tetramethyl ethylene, dimethyl cyclohexene, and phenyl acetylene with benzoyl peroxide and benzoyl hydroperoxide are described. TAB

N68-18492# Societa Ricerche Impianti Nucleari, Saluggia (Italy).
DEVELOPMENT OF A RADIOMETRIC METHOD FOR THE AUTOMATIC ANALYSIS OF PHOSPHATES AND SULPHATES IN AQUEOUS SOLUTION [MISE AU POINT D'UNE METHODE RADIOMETRIQUE D'AUTOMATISATION DES ANALYSES DE PHOSPHATES ET DE SULFATES EN SOLUTION AQUEUSE] Final Report
A. Bruna, P. G. Caldera, and P. L. Tarditi Brussels EURATOM Feb. 1968 40 p refs In ITALIAN; ENGLISH summary
(Contract EURATOM-034-65-4 IRAI)
(EUR-3738.F; R-466) CFSTI: HC $3.00/MF $0.65

This report contains the description of two methods of analyzing sulphates and phosphates in aqueous solution using radioisotope-labelled reagents. The sulphates are assayed with Sr-89 in the presence of dioxan which reduces the solubility of the strontium sulphate in water; the phosphates are assayed with ammonium molybdate, then the phosphomolybdic complex is extracted by means of a mixture of organic compounds, using P-32 as labelled reagent. The use of labelled reagents permits automation of both analyses, and for this purpose two manually-controlled semi-automatic rigs have been developed, by which sulphates and phosphates can be analyzed in about ten to fifteen minutes. The report gives the results of analyses performed on sulphate and phosphate samples with various concentrations ranging from a few ppm to several thousand. The results are satisfactory: the analyses are of high precision and sensitivity, the precision margin being about ±1%. Two examples of the application of the developed methods to two industrial analyses are also described, namely the analysis of phosphates in phosphate fertilizers, and the analysis of sulphates in the brine used in mercury-cathode electrolysis cells for the production of chlorine and soda. Author

N68-18498# European Atomic Energy Community, Karlsruhe (West Germany). Joint Nuclear Research Center.
SOME CONSIDERATIONS ON THE INFRARED ABSORPTION SPECTRUM OF PuO_2 POWDERS AND SINTERED PELLETS
L. Manes, A. Barisich, and K. Buijs Brussels Jan. 1968 24 p refs
(EUR-3739.E) CFSTI: HC $3.00/MF $0.65

Infrared absorption measurements have been performed on PuO_2 powders and sintered pellets in the spectral range of 4 to 50 μ. A resonance frequency has been found at 360±10 cm^{-1}, attributable to one-phonon fundamental absorption ("Reststrahlen" absorption). On the short wave length side of this absorption band a detailed structure is found, attributable to many-phonon combinations. A remarkable similarity is found between the spectrum of PuO_2 and those of UO_2 and ThO_2. A discussion is given of the effect of sizes and shapes of the crystals on the one-phonon resonance frequency, in the light of recent theories. Author

N68-18519 Texas Univ., Austin.
THE PREPARATION AND CRYSTAL STRUCTURE STUDIES OF SELECTED AB_2 RARE EARTH INTERMETALLIC COMPOUNDS WITH GROUP 5 AND 6 ELEMENTS
Rong Wang (Ph.D. Thesis) 1967 138 p
Available from Univ. Microfilms: HC $6.60/MF $3.00 Order No. 67-8172

A number of selected compounds of the rare-earth elements, lanthanum, cerium, neodymium, samarium, gadolinium, dysprosium, holmium, erbium and ytterbium in combination with the elements of chemical Groups V and VI, antimony, selenium and tellurium have been prepared and their crystal structures studied. Dissert. Abstr.

N68-18528# Boston Univ., Mass.
FUNDAMENTAL CHEMISTRY OF ORGANOTIN COMPOUNDS Final Report, 1 Sep. 1965–30 Nov. 1967
Ernest I. Becker and Abraham N. Fenster 1 Dec. 1967 10 p refs
(Contract DA-31-124-ARO(D)-412)
(AROD-6151-1-C; AD-664200)

A summary is given of studies involving the thermal decomposition triphenyltin nitrate, tri-p-tolyltin nitrate, and diphenyltin dinitrate. A list of publications resulting from the work is included. TAB

N68-18532# Oak Ridge National Lab., Tenn.
CONTAINERS FOR MOLTEN FLUORIDE SPECTROSCOPY
L. M. Toth 8 Nov. 1967 21 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-2047) CFSTI: HC $3.00/MF $0.65

Techniques used previously for visible-uv absorption spectroscopy of molten fluoride salts are reviewed and evaluated. Numerous optical materials that could be useful for fluoride spectroscopy are suggested on the basis of thermodynamic predictions and limited testing. It was concluded that quartz should be used to its practical limits and perhaps then should be coated with transparent metal films in order to extend its usefulness. Ultimately, however, diamond-windowed metal cells are viewed as the only corrosion-resistant absorption cell for fluorides above 500°C. Author (NSA)

N68-18628# Michigan Univ., Ann Arbor. Dept. of Mechanical Engineering.

COMBUSTION KINETICS OF TETRAFLUOROETHYLENE Final Technical Report

Richard A. Matula Sep. 1967 23 p refs

(Grant AF-AFOSR-1144-66)

(AFOSR-68-0099; AD-664088)

The oxidation kinetics of tetrafluoroethylene and the pyrolysis of carbonyl fluoride were experimentally studied in the temperature range 500-750K. Both infrared spectroscopic and gas chromatographic techniques were developed for the quantitative analysis of all important reaction products. The pyrolysis of CF2O was studied in the temperature range 500-750K. When the studies are conducted in a quartz reactor vessel, the only significant gaseous products are CF2O, CO2, and SiF4. Preliminary analysis of the kinetic data indicate that both the heterogeneous rate of production of CO2 and rate of consumption of CF2O are half order with respect to CF2O. Prior to the initiation of the C2F4 oxidation experiments, the pyrolysis of C2F4 was studied at 636K. The only important product was c-C4F8, and the rate was shown to be second order with respect to C2F4. The second order rate constants as evaluated from both the experimentally determined rate of production of c-C4F8 and the rate of decrease of C2F4 are reported. Preliminary oxidation experiments employing an equimolar mixture of O2 and C2F4 at 636K and an initial pressure of 50 mm of Hg indicate that the oxidation reaction is fast and that only the significant reaction products are CF4, CO2, and CF2O. Author (TAB)

N68-18728# United Kingdom Atomic Energy Authority, Windscale (England).

ANALYTICAL METHOD FOR THE DETERMINATION OF PLUTONIUM IN PLUTONIUM METAL (DIFFERENTIAL SPECTROPHOTOMETRY)

1968 7 p Revised

(PG-290(W))

A solution of plutonium metal in hydrochloric acid is maintained in the trivalent state with hydroxylamine hydrochloride. The relative absorbancy of the solution is measured at 561 mμ against a plutonium reference standard. Author

N68-18736# United Kingdom Atomic Energy Authority, Windscale (England). Production Group.

SOME ASPECTS OF THE CHEMISTRY OF RUTHENIUM IN SEA WATER

P. D. Wilson 1968 11 p refs

(PG-819(W))

The effluent discharged to sea from the Windscale Works contains radio-ruthenium both in solution and in the form of a co-precipitate with ferric hydroxide. Laboratory experiments on synthetic ruthenium solutions indicate that in sea water an equilibrium is set up between cationic, anionic and perhaps neutral ruthenium complexes. Ruthenium is therefore taken up by both anion- and cation-exchangers, and by the polysaccharide porphyran which is a major constituent of the edible seaweed Porphyra. It is also adsorbed strongly by ferric hydroxide particles. In all cases the extent of sorption increases slowly over a period of weeks or months. Ruthenium co-precipitated with ferric hydroxide is only superficially leached by sea water. Since, after ageing, the particles become resistant to acid, ruthenium in this form is not a serious source of contamination to the tissues of marine organisms. Author

N68-18761# Atomic Energy of Canada, Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment.

THE DETERMINATION OF CHLORINE AND FLUORINE IN ZIRCONIUM OXIDE AND ZIRCONIUM. SOME EXPERIENCE WITH A PYROHYDROLYSIS PROCEDURE

R. B. Stewart, S. Elchuk, and M. A. Grant Nov. 1967 20 p refs

(AECL-2799) Available from Atomic Energy of Canada, Ltd., Chalk River: $0.50

A procedure for the determination of chlorine and fluorine in refractory solids and metals is described and evaluated. It uses a pyrohydrolytic separation at 1000°–1100°C. The measurement of chloride is by potentiometry or colorimetry, that of fluoride by spectrophotometry. Sensitivities of 1 μg/g are attainable. Data derived from known additions are given and discussed. Author

N68-18762# Atomic Energy of Canada, Ltd., Chalk River (Ontario).

THE EFFECT OF WATER CHEMISTRY ON THE OXIDATION OF ZIRCONIUM ALLOYS UNDER REACTOR RADIATION

J. E. Lesurf and P. E. C. Bryant Feb. 1968 17 p refs Presented at High Purity Water Symp., NACE 23d Ann. Conf., Los Angeles, Mar. 1967

(AECL-2797) Available from Atomic Energy of Canada, Ltd., Chalk River: $0.50

With pressurized water coolant, reactor radiation reportedly has no effect on the high-temperature oxidation of Zircaloy 2, but boiling water tends to increase oxidation. This paper presents corrosion data for Zircaloy 2 and Zr-2.5% Nb, oxidized in reactor radiation by water containing excess oxidizing or reducing agents. Both oxidizing chemistry and damaging radiation are required to enhance the oxidation of Zircaloy 2; oxygen in the absence of neutrons has little effect, and neutrons fail to enhance oxidation under reducing-chemistry conditions. The sensitivity of Zr-2.5% Nb alloy to radiation and water chemistry depends upon its metallurgical structure, but generally it is sensitive to oxygen in all environments. Radiation appears to have no accelerating effect on Zr-2.5% Nb oxidation other than that associated with oxygen production from the radiolysis of water. Addition of ammonia to the water prevents the appearance of molecular oxygen out-reactor and reduces the oxidation of both alloys. K.W.

N68-18829# Iowa State Univ. of Science and Technology, Ames.

GAS CHROMATOGRAPHY AND FRAGMENTATION-GAS CHROMATOGRAPHY OF DIPHOSPHINE OXIDES AND URANYL NITRATE–DIPHOSPHINE OXIDE COMPLEXES

Michael Richard Guerin (Ph.D. Thesis) Nov. 1967 167 p refs

(Contract W-7405-ENG-82)

(IS-T-184) CFSTI: HC $3.00/MF $0.65

A 4-ft 0.25-in. OD, column of 5% SE-30 on DMCS-treated Chromosorb G operated at 290°C with a carrier gas (He) flow rate of 120 ml/min was found well suited for the gas chromatography of the diphosphine oxides provided that glass columns and glass-lined inlets are employed. Loss of sample to column adsorption and to thermal decomposition was found minimal. Adjusted retention distances of the diphosphine oxides were found related to their boiling points and the number of methylene groups in their respective methylene bridges. Flame ionization detector response factors and quantitative detection limits ($\approx 10^{-6}$M) are obtained for the diphosphine oxides. Electrical discharge fragmentation-gas chromatography patterns were obtained for the diphosphine oxides and uranyl nitrate–diphosphine oxide complexes. Patterns obtained with programmed column temperatures are found sufficiently compound specific to allow the identification of the diphosphine oxides but are not significantly influenced by complexation. Patterns

obtained at ambient column temperatures are found useful for the identification of the alkyl side chains of the diphosphine oxides and found to exhibit complexation influences. Compounds are assigned to the peaks making up the ambient column temperature patterns and the influence of complexation is related to the metal content of the fragmented sample. The effects of operating parameters on the ambient column temperature fragmentation patterns are discussed. The relationship $\Delta R_m = (b/100)\delta I$ is shown useful for the computation of retention indices for the fragments making up fragmentation patterns. Author (NSA)

N68-18884 Vanderbilt Univ., Nashville, Tenn.
A STUDY OF THE EFFECT OF COORDINATION ON THE REACTIVITY OF AROMATIC LIGANDS
Naresh Kumar Chawla (Ph.D. Thesis) 1967 80 p
Available from Univ. Microfilms: HC $4.20/MF $3.00 Order No. 67-7444

Bis(8-Hydroxyquinolinato) copper (II) has been found to undergo a large number of electrophilic substitution reactions. Benzoylation, sulfonation, nitration, thiocyanation, mercuration, and condensation with formladehyde can be effected readily on the complex. Iodination can be effected, but only in poor yields, while acetylation fails. A kinetic study of the mercuration of 8-hydroxyquinoline and its copper (II) complex has been carried out in glacial acetic acid. The rate of mercuration with the copper complex is much greater than with 8-hydroxyquinoline. The rate of mercuration of the copper complex is significantly changed by the addition of either copper (II) acetate or 8-hydroxyquinoline. An improved method of preparing 8-hydroxyquinoline-5-sulfonic acid has been developed. Dissert. Abstr.

N68-18885 California Inst. of Tech., Pasadena.
CHARACTERIZATION OF THE ANODICALLY FORMED OXIDE FILM ON PLATINUM ELECTRODES. DEVELOPMENT OF ELECTROCHEMICAL INSTRUMENTATION
George Lauer (Ph.D. Thesis) 1967 275 p
Available from Univ. Microfilms: HC $12.40/MF $3.55 Order No. 67-6159

The oxygen containing film formed at anodically polarized platinum electrodes in oxyacid solutions has been characterized. By making use of a thin layer electrode it is shown that the film is composed of Pt(II) and Pt(IV) oxides. This was proven by oxidizing the electrodes, and then stripping the oxides with acidic chloride solution and then analyzing, coulometrically, the platnium chlorides in solution. It is shown that the discrepancy between anodic charge passed during oxidation and the cathodic charge passed during reduction is due to Pt(IV) oxide which is not reducible at potentials anodic of the hydrogen evolution reaction. The oxides decompose slowly in formal sulfuric acid to form hydrogen peroxide and platinum; elevated temperatures accelerate the decomposition. A correlation is drawn between the presence of Pt(IV) on the surface of the electrode and "activation" of the electrode. It is concluded that the cause of activation is irreducible oxide. Dissert. Abstr.

N68-18886 Houston Univ., Tex.
$Hg(6^1P_1)$ PHOTOSENSITIZED REACTIONS OF ETHYLENE
Norman Lee Ruland (Ph.D. Thesis) 1967 98 p
Available from Univ. Microfilms: HC $5.00/MF $3.00 Order No. 67-7343

An experimental system for the study of $Hg(6^1P_1)$ photosensitized reactions was developed. Ethylene decomposition was carried out over a pressure range from 10 to 130 torr with illumination times of ten and twenty minutes. Decrease in product yields at higher ethylene pressures indicated that an excited state of ethylene was formed prior to decomposition. It was calculated that vinyl radical formation constituted at least 42% of the primary decomposition. Addition of xenon to the reaction system was observed to enhance both ethylene decomposition and the $(C_2H_2)/(H_2)$ ratio. Decomposition enhancement was attributed to pressure broadening of the mercury absorption line resulting in a higher population of $Hg(6^1P_1)$ atoms. CH_2CD_2, cis- and trans-CHDCHD, and C_2D_4 were photosensitized, and the distributions of the isotopic hydrogens produced were determined by mass spectrometry. The results were markedly different from those of the 1849Å photolysis, indicating that some excited species other than ethylene $^1B_{1u}$ were involved in the decomposition. Dissert. Abstr.

N68-18889 Texas Univ., Austin.
STUDY OF STRUCTURE AND REACTIONS OF THE IODIDES OF PHOSPHORUS
Scott Towers Cohen (Ph.D. Thesis) 1967 101 p
Available from Univ. Microfilms: HC $5.20/MF $3.00 Order No. 67-8097

The infrared spectral technique was used to study the structures of P_2I_4 and PI_3 both in the solid state and in solution. The infrared spectra of PI_3 merely strengthened the previous C_{3v} point group assignment to that molecule. The solid state infrared spectrum of P_2I_4 was in complete agreement with the trans (C_{2h}) conformation found previously by X-ray crystallography. However, upon dissolution in CS_2, there is apparently a change in conformation from trans (C_{2h}) to gauche (C_2) as evidenced by the appearance of two new bands in the P-I stretching region. However, a more definite assignment should await the results of a Raman spectral study. Satisfactory agreement was found between the observed P-I stretching vibrations and those calculated by Gordys' rule. Dissert. Abstr.

N68-18891 Stanford Univ., Calif.
SOME OXIDATION-REDUCTION REACTIONS OF THE AMMINE COMPLEXES OF RUTHENIUM
Thomas J. Meyer (Ph.D. Thesis) 1967 113 p
Available from Univ. Microfilms: HC $5.60/MF $3.00 Order No. 67-7948

The kinetics of the electron exchange reactions between $Ru(NH_3)_6^{2+}$ and $Ru(ND_3)_6^{3+}$ and between $Ru(en)_3^{2+}$-H and $Ru(en)_3^{3+}$-D were studied in D_2O using an infrared spectrophotometric technique. For the hexaammine exchange $\Delta H^{\ddagger} = 10.3 \pm 1.0$ kcal/mole and $\Delta S^{\ddagger} = -11 \pm 3$ e.u. and for the tris-(ethylene-diamine) exchange $\Delta H^{\ddagger} = 2.2 \pm 0.5$ and $\Delta S^{\ddagger} = -41 \pm 2$ e.u. at $\mu = 0.013$ in deuterotrifluoroacetic acid. However, the initial results for the latter reaction were not reproducible. The standard oxidation potentials for the $Ru(NH_3)_6^{2+/3+}$, $Ru(en)_3^{2+/3+}$ and $Ru(NH_3)_5OH^{2+/3+}$ couples were measured and were -0.101 ± 0.003 v, -0.208 ± 0.003 v and $-0.16 \pm .01$ v respectively at 25°C. The rate law for the Fe(III) oxidations of $Ru(NH_3)_6^{2+}$, $Ru(en)_3^{2+}$ and $Ru(NH_3)_5OH^{2+}$ at pH 1–3 was found to be: $-d/(Fe_T(III)/dt = k_1(Ru(II)Fe^{3+}) + k_2(Ru(II)FeOH^{2+})$ were $Fe_T(III) = (Fe^{3+}) + (FeOH^{2+})$. Dissert. Abstr.

N68-18892 Stanford Univ., Calif.
STEREOCHEMISTRY OF CYCLOHEXENE DERIVATIVES. PART 1. ABSOLUTE CONFIGURATION OF TRIFLUOROMETHYLCARBINOLS, PART 2
Howard McDowell Peters (Ph.D. Thesis) 1967 106 p
Available from Univ. Microfilms: HC $5.40/MF $3.00 Order No. 67-7956

Proton magnetic resonance spectroscopy (pmr) was utilized to examine the stereochemistry of *cis*- and *trans*-2,3-dimethyl-1,2,3,4-tetrahydronaphthalenes and *cis*- and *trans*-4,5-dimethylcyclohexenes. The pmr signal corresponding to the protons adjacent to the methyl groups in the spectra of the *trans* isomers is about 0.5 ppm towards higher field from the corresponding proton signal of the *cis* isomers. This chemical shift difference is attributed to the predominant axial orientation of these hydrogens in the quasi-chair configuration of the *trans* isomers (Ia) as opposed to the average axial-equatorial orientation in the *cis* isomers (Ib=Ic). An investigation to determine the absolute configurations of trifluoromethylcarbinols in an unequivocal manner

was undertaken. After consideration of the possible methods of correlation of configuration, it was decided to synthesize the appropriate derivatives in a manner which would not break any bond to the asymmetric carbon atom. Dissert. Abstr.

N68-18896# United Kingdom Atomic Energy Authority, Harwell (England). Research Group.

THE SEPARATION, PURIFICATION, MOUNTING AND COUNTING OF FISSION PRODUCTS

J. G. Cuninghame, J. A. B. Goodall, G. P. Kitt, C. B. Webster, and H. H. Willis Oct. 1967 85 p

(AERE-R-5587) HMSO: 12s

Described are procedures for group separation of specific fresh fission products from each other and from up to gram amounts of various fissile materials, and procedures for purifying the separated fission products. Data on carrier preparation and standardisation source mounting, and counting are included. Author

N68-18926 Texas Univ., Austin.

SPECTROSCOPY OF SOLUTIONS OF ALKALI METALS IN FUSED ALKALI METAL SALTS

James Frederick Rounsaville (Ph.D. Thesis) 1967 154 p

Available from Univ. Microfilms: HC $7.20/MF $3.00 Order No. 67-8155

The spectra of alkali metals in alkali metal salts, primarily halides, and mixtures of alkali halides were determined in order to elucidate the nature of the species presented. For most of the work pyrex (below 550°C) and quartz (for higher temperatures) optical cells were used. The solvent salts were dried either by passing chlorine through them while fused or by thermal drying under vacuum. The results show that the position of the band maximum varies with the ionic sizes and with the composition in mixtures of salts. The band is similar for all cases studied and has a relatively large half height width. The nature of the particular metal added has no effect on the band as long as any color is present. The only species which can account for these results is a solvated electron; the electron would be solvated primarily by cations and secondarily by anions. Dissert. Abstr.

N68-18932# Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires.

ANALYSIS AND SEPARATION OF BORON ISOTOPES [ANALYSE ET SEPARATION DES ISOTOPES DU BORE]

Michele Perie (Ph.D. Thesis—Paris Univ.) 1967 70 p refs In FRENCH

(CEA-R-3230)

The nuclear applications of ^{10}B justify the study of a method of measuring its isotopic abundance as well as of very small traces of boron in different materials. A systematic study of thermoionic emission of $BO_2Na^+_2$ was carried out. In the presence of a slight excess of alkalis, the thermoionic emission was considerably reduced. On the other hand, the addition of a mixture of sodium hydroxide–glycerol (or mannitol) to borax permits an intense and stable beam to be obtained. These results permitted an operative method to be established for analysis of traces of boron by isotopic dilution. Procedures for separation of isotopes of boron were studied. A considerable isotopic effect was exhibited in the chemical exchange reaction between methyl borate and borate salt in solution. In the case of exchange between methyl borate and sodium borate, the elementary separation factor α is: $\alpha = (^{11}B/^{10}B)_{vap}/(^{11}B/^{10}B)_{liq} = 1.03_3$ The high value of this elementary effect was multiplied in a distillation column in which the problem of regeneration of the reactivities was resolved. An alternative procedure replacing the alkali borate by a borate of volatile base, for example diethylamine, was also studied ($\alpha = 1.02_5$ in a hydromethanolic medium with 2.2% water). Author (NSA)

N68-18950# Forsvarets Forskningsanstalt, Stockholm (Sweden).

RAPID SPECTROPHOTOMETRIC DETERMINATION OF PLUTONIUM

Lars-Henrik Andersson and Eva-Britt Bauren Repr. from FOA Rept., v. 1, no. 6, Dec. 1967 p 1–4 refs

CFSTI: HC $3.00/MF $0.65

Seeking a method for the rapid determination of plutonium in solutions of nitric acid, we investigated the reduction of plutonium ions to Pu(III) ions and the measurement of the resulting color at 567 nm. Only moderate precision was aimed at. The reducing agent was ascorbic acid. We studied the effect of the amount of reducing agent added, the nitric acid concentration and the presence of certain impurities. The method was applied to solutions containing 0.5–10 mg plutonium per g of solution (2–40 mM). If reasonable care is taken to control the nitric acid concentration of the solutions, a standard deviation of 0.07 mg plutonium per g of solution (0.3 mM) may be obtained with a single measurement. Sulfamic acid was added to the solution to be reduced to increase its stability after reduction. The time required for a determination is approximately 15 minutes. Author

N68-18956# Los Alamos Scientific Lab., N. Mex.

A THERMODYNAMIC TREATMENT OF ANION-EXCHANGE ABSORPTION OF METALS

James S. Coleman 5 Dec. 1967 7 p refs

(Contract W-7405-ENG-36)

(LA-3819) CFSTI: HC $3.00/MF $0.65

A thermodynamic description is given of the equilibrium distribution of a metal between an aqueous phase and an anion exchanger. The approach follows the lines established by Fronaeus, Marcus and Coryell, and Kraus and Nelson. Explicit account is taken of stepwise complex formation in each phase, Donnan invasion of the resin, and the formation of polymerized, hydrolyzed, and weakly acid complex ions. Author (NSA)

N68-18962# European Atomic Energy Community, Ispra (Italy).

FABRICATION AND PROPERTIES OF CHEMICAL VAPOR DEPOSITED NB LAYERS ON AL_2O_3 BODIES FOR THERMIONIC APPLICATION

P. Fiebelmann Brussels Feb. 1968 21 p refs

(EUR-3743.E) CFSTI: HC $3.00/MF $0.65

A recently developed CVD process for refractory metal plating is of interest as regards the fabrication of Nb–Al_2O_3–Nb sandwiches for thermionic application. The process uses Zn for the reduction of refractory metal chlorides. Nb deposition is in accordance with the reaction: 2 Nb Cl_5 + 5 Zn → 5 Zn Cl_2 + 2 Nb. A laboratory apparatus for plating Al_2O_3-tubes is described and working data given. The influence of pressure and temperature change is discussed, as well as the most important factors to be considered in the plating procedure. Results relating to the layer properties are shown. The main features after outgassing at 1650°C are: chemical purity, good surface adherence, even during sharp thermal cycles; and equal layer thickness. For application in the 800 to 1100°C temperature range, brazing and diffusion bonding of Nb-plated Al_2O_3-bodies have proved feasible. Related results are also communicated. Author

N68-18964# European Atomic Energy Community, Karlsruhe (West Germany).

FORMATION OF COLLOIDAL SOLUTIONS OF Pu^4 AND THE CONVERSION INTO PuO_2 MICROSPHERES

K. P. Louwrier, T. Steemers, and E. Zamorani Brussels Jan. 1968 20 p refs

(EUR-3737.E) CFSTI: HC $3.00/MF $0.65

Different methods to produce sols of PuO_2 are presented and the feasibility to form microspheres is tested. Formation of microspheres with a tapered column and in a beaker is described. Thermogravimetric analysis in connection with the drying procedure is discussed. Metallographic inspection of the microspheres is presented. Author

N68-18967# Indiana Univ. Foundation, Bloomington.
DEUTERIUM AND TRITIUM EFFECTS ON THE RATES OF ORGANIC REACTIONS Annual Technical Progress Report
Dec. 1967 22 p refs
(Contract AT(11-1)-1008)
(COO-1008-3) CFSTI: HC $3.00/MF $0.65

Research progress is reported on deuterium and tritium effects on the rates of organic reactions. Topics covered include: deuterium effects on solvolysis of isopropyl p-bromobenzenesulfonate, solvolytic α-deuterium effects for different leaving groups, deuterium effects on solvolysis of optically active α-phenylethyl chlorides, hydrogen participation in 2,6-dimethylcyclohexyl p-bromobenzenesulfonate solvolysis, α-deuterium effects on rates of solvolysis of some substituted benzyl halides and arenesulfonates, temperature and solvent dependence of isotope effects in the solvolysis of some 1-phenylethyl halides, mechanism and isotope effects in the solvolysis of some propargyl compounds, and β- and γ-deuterium effects on the solvolysis rate of pinacolyl brosylate. NSA

N68-19035# Centre d'Etude de l'Energie Nucleaire, Mol (Belgium).
REPROCESSING OF IRRADIATED FUELS Quarterly Report, 1 Apr.–30 Jun. 1967
30 Jun. 1967 86 p refs
(Contracts EURATOM-006-65-7-RCIB(RD); EURATOM-016-65-1-RAP(B))
(EURAEC-1934; EUR-3758; QR-29) CFSTI: HC $3.00/MF $0.65

Research was continued on the use of ClF_3 as a fluorinating agent for direct attack on compact ceramic fuels, with the aim of cutting out the need for prior atomization. Efforts were made to determine the influence of the plutonium concentration on the rate of uranium volatilization from compact material. The tests were carried out on uranium dioxides and on mixed uranium and plutonium dioxides. One investigation was carried out on pellets in a licked bed, and another on high-density microspheres using a thermobalance. It was concluded that chlorine trifluoride at 300°C can be used for direct attack on these high-density compact mixed dioxides. At plutonium contents of around 20%, the rate of uranium volatilization was sharply reduced but the reaction residue was still broken up and atomized. The uranium was entirely volatilized before any plutonium volatilization became apparent. Author (NSA)

N68-19036# Commissariat a l'Energie Atomique, Saclay (France).
HEATS OF FORMATION OF GASEOUS URANIUM FLUORIDES [CHALEURS DE FORMATION DES FLUORURES D'URANIUM GAZEUZ]
I. N. Godnev and A. S. Suerdlin 1966 9 p refs Transl. into FRENCH from Izv. Vyssh. Ucheb. Zaved., Khim. i Khim. Tekhnol. (Moscow), v. 9, 1966 p 40–43 In FRENCH
(CEA-TR-R-1905) CFSTI: HC $3.00/MF $0.65

The heats of formation of gaseous uranium fluorides, UF_n, are given for n=1, 2, 3, 4, and 5. Equations are given for determining the values for UF_4. For the other fluorides, two methods were used. The first method was based on the construction of curves of heats of formation of gaseous fluorides, UF_n from F(gas) and U(gas) as a function of n. The second method was based on the construction of a curve of heats of dissociation or the thermal effects on the reaction at 298°K as a function of n. Data are tabulated and compared. NSA

N68-19055# Mound Lab., Miamisburg, Ohio.
DATA SHEETS ^{238}Pu AND ^{210}Po
29 Sep. 1967 91 p refs
(Contract AT(33-1)-GEN-53)
(MLM-1441) CFSTI: HC $3.00/MF $0.65

A compilation of data available as of October 1967, for the fuel forms ^{238}Pu and ^{210}Po is presented. Properties of plutonium metal, PuO_2 microspheres, PuO_2, PuC, PuN, Pu-20 at. % Zr alloy, Pu-10 at. % Zr alloys, polonium metal, gadolinium polonide, and gadolinium polonide in a Ta matrix are given. NSA

N68-19107 Texas Univ., Austin.
THE CONDUCTIVITIES OF SOLUTIONS OF DIVALENT METALS IN AMMONIA
Paul Leonard Oertel, Jr. (Ph.D. Thesis) 1967 114 p
Available from Univ. Microfilms: HC $5.60/MF $3.00 Order No. 67-8143

Calcium, strontium, barium and ytterbium were dissolved in liquid ammonia and the conductivity measured as a function of metal concentration and temperature. The concentration, measured as a ratio of metal to ammonia, ranged from 0.02 to 0.09 and the temperature from 180°K to 240°K. The phase diagrams of these metal–ammonia solutions were determined from discontinuities in conductivity versus concentration and temperature plots. The properties of these four metal solutions were compared to those of monovalent metals dissolved in ammonia and using the Ziman theory of liquid metals, information was obtained as to the structure of metal–ammonia solutions. Debye's theory of ion-dielectric saturation was shown to account for the temperature coefficient of the conductivity. Dissert. Abstr.

N68-19133 Massachusetts Univ., Amherst.
THE RAMAN AND INFRARED SPECTRA OF PYRIDAZINE AND DEUTERO-PYRIDAZINES
James Vincent Tucci (Ph.D. Thesis) 1967 65 p
Available from Univ. Microfilms: HC $3.60/MF $3.00 Order No. 67-7401

Infrared spectra of the liquids pyridazine, pyridazine-d_4 and pyridazine-3,6-d_2 are reported from 270 to 4,000 cm^{-1}. Raman spectra are reported for these liquids with the state of polarization for many lines. The vibrational assignment suggested for these three compounds satisfies the three Teller–Redlich product rules within limitations imposed by evident Fermi resonance perturbation of several of the fundamentals. A method of synthesis of pyridazine-4,5-d_2 was proposed and tested, and preliminary liquid phase infrared data are reported together with a few suggested assignments for this compound. Dissert. Abstr.

N68-19134 Catholic Univ. of America, Washington, D. C.
SOME NOTES ON THE KINETICS OF GROWTH OF MULTICOMPONENT CHAINS WITH APPLICATION TO THE PROBLEMS OF CILIATION AND FRACTIONATION IN POLYMER CRYSTALLIZATION
Edmund Armand Di Marzio (Ph.D. Thesis) 1967 102 p
Available from Univ. Microfilms: HC $5.20/MF $3.00 Order No. 67-7327

The problem of the growth rate and purity of crystals formed by the sequential deposition of molecules in a mixed system is solved. The solution is given in terms of the fundamental rates for laying down (taking off) species at the position of the growing crystal. The fundamental rates are thus dependent on nearest-neighbor interaction but not on neighbors further removed. It is shown that there exists one unique flux-determined steady state solution for a wide variety of initial conditions. Several diagrams descriptive of various physical processes are displayed. The one describing ciliation (the growth process which results in the ends of polymer chains dangling out of the crystal lamella) is treated in some detail. Formulae are given for the purity of polymer crystals which are formed by high molecular weight material crystallizing concomitantly with polymeric material of lower molecular weight and/or of different kind. Dissert. Abstr.

N68-19174# Toledo Univ., Ohio. Dept. of Chemistry.
CHEMICAL EFFECTS OF NUCLEAR TRANSFORMATIONS, FLASH HEATING OR FLASH PHOTOLYSIS Technical Progress Report, 1 Feb.–31 Oct. 1967
Jack G. Kay 31 Oct. 1967 16 p refs
(Contract AT(11-1)-1684)
(COO-1684-2) CFSTI: HC $3.00/MF $0.65

Progress is reported on the study of effects of flash heating on the surface of an alumina catalyst; study of $KMnO_4$ crystals and their decomposition due to flash photolysis and flash heating; flash heating and kinetic spectroscopy, manganese oxide problem; flash heating and kinetic spectroscopy, titanium monohalides; and chemical effects of nuclear transformations and annealing in inorganic crystals. NSA

N68-19197# Portugal. Nuclear Energy Commission, Sacavem.
INTRAMOLECULAR CATION TRANSFER
A. F. Neiva Correia (Ph.D. Thesis—Amsterdam Univ.) 1967 134 p refs
(LFEN-79)

Negative ions of the aromatic nitriles, phthalonitrile and terephthalonitrile, were studied and the results indicate a temperature-dependent line width alternation effect when associated with alkali cations in 2-methyltetrahydrofurane (MTHF), tetrahydrofurane (THF), and 1, 2 dimetoxyethane (DME). The density matrix method was used to derive an expression to relate the line width, which is a function of temperature, with the frequency of exchange. The first order constants obtained for the intramolecular transfer reaction gave straight Arrhenius plots from which the activation parameters were calculated. These parameters were found to be correlated with the thermodynamic constants for the dissociation of the complexes. It is concluded that the data show an increase in solvation in the transition state with respect to the initial and final state of the complex. M.G.J.

N68-19218 Texas Univ., Austin.
THE LOW TEMPERATURE HEAT CAPACITY OF TETRAAMMINE LITHIUM
Jerry Allen Morgan (Ph.D. Thesis) 1967 76 p
Available from Univ. Microfilms: HC $4.20/MF $3.00 Order No. 67-8138

The specific heat of tetraammine lithium was measured over the temperature range 2.1°K to 4.2°K by a non-adiabatic, heat burst method. The Debye characteristic temperature was found to be 51.3±.2°K. Due to the low electron density and to the low Debye temperature no significant value could be determined for the electronic specific heat. The specific heat of 99.9% pure cesium metal was also measured from 2.1°K to 4.2°K as a test of the apparatus. The Debye characteristic temperature was found to be 38.5±1.0°K which is in agreement with literature values. Dissert. Abstr.

N68-19258 North Carolina State Coll., Raleigh.
THERMOCHEMICAL, COMPATIBILITY, AND WETTABILITY STUDIES OF HIGH-TEMPERATURE MOLYBDENUM–RHENIUM BASE CERMETS
Charles Richard Manning (Ph.D. Thesis) 1967 146 p
Available from Univ. Microfilms: HC $7.00/MF $3.00 Order No. 67-7425

An investigation was undertaken to determine the stability, compatibility, and adhesion of various high melting oxides, borides, nitrides, and carbides in combination with Groups VIB and VIIB refractory metals. The results of these studies were analyzed to allow prediction of suitable metal–ceramic system for high temperature cermets. The thermochemical studies predicted excellent stability between the oxides, carbides, and nitrides in contact with molybdenum, rhenium, and tungsten below 2230°C and instability between the borides and carbon. Sessile drop tests indicated little wetting occurred between refractory metals and oxides although the wetting could be improved by raising the test temperature. The most promising metal-oxide system was vanadium on zirconia. In this system, a contact angle of 46° was noted at 1700°C indicating partial wettability. Based on the above mentioned studies, specimens were fabricated from 25 and 50 volume percent molybdenum-40 weight percent rhenium, and 75 and 50 volume percent hafnium carbide or zirconium carbide. The resulting microstructure was a uniformly dispersed ceramic phase surrounded by a thin metal film. Strength values for transverse rupture tests on molybdenum–rhenium alloy in combination with hafnium carbide were 180 ksi, and densities were 93 to 94 percent of theoretical. Dissert. Abstr.

N68-19259# Union Carbide Corp., Oak Ridge, Tenn. Nuclear Div.
EMISSION SPECTROGRAPHIC ANALYSIS OF PURIFIED CALCIUM METAL
J. H. Stewart, Jr. and C. M. Neff 14 Nov. 1967 14 p refs
(Contract W-7405-ENG-26)
(Y-1590) CFSTI: HC $3.00/MF $0.65

A successful method for determining fifteen trace impurities in pure calcium was developed. The average limit of error at the 95% confidence level for the fifteen elements determined was ±16.3% at the lowest level and ±14.9% at the highest level. The simplicity of sample preparation and utilization of dc arc excitation provide improved accuracy at a lower cost when compared to the emission spectrographic analysis of calcium oxide previously used. Author (NSA)

N68-19265# Rocket Flats Div., Dow Chemical Co., Golden, Colo.
STATIC BED REACTOR FOR STUDIES OF A PLUTONIUM HEXAFLUORIDE VOLATILITY PROCESS
Jerry D. Moseley and Herbert N. Robinson 5 Dec. 1967 19 p
(Contract AT(29-1)-1106)
(RFP-1048) CFSTI: HC $3.00/MF $0.65

Studies were begun to find if chemical separation and purification of plutonium from waste material could be achieved with fluoride volatility processes. Equipment designed for the project and for the procedures developed for use are described. Author (NSA)

N68-19270 Stanford Univ., Calif.
THE THERMODYNAMICS OF THE LIQUID NORMAL PARAFFIN HYDROCARBONS AND THEIR BINARY MIXTURES
Robert Arvid Orwoll (Ph.D. Thesis) 1967 149 p
Available from Univ. Microfilms: HC $7.00/MF $3.00 Order No. 67-7955

A simple partition function for hydrocarbon liquids has been derived from a treatment of a one-dimensional liquid comprising hard spheres. The intermolecular energy is assumed inversely proportional to the molar volume. The equation of state determined by the partition function contains for each n-alkane three parameters which can be evaluated from its density, thermal expansion coefficient, and thermal pressure coefficient. These three properties have been measured for n-hexane, n-octane, n-hexadecane, n-docosane, n-hexatriacontane, and two samples of linear polymethylene over a wide range of temperatures. The results of these experiments and critically selected data from the chemical literature yield characteristic parameters which exhibit slight temperature dependence. When these parameters are evaluated at each temperature at which they are used, the theoretical isotherm is able to account for 90–100% of the measured compressions at 1000 bars; the theoretical isobar overestimates the temperature dependence of the thermal expansion coefficients. The functional dependence of the three parameters on chain length as dictated by the theory offers a means for accurately predicting expansion coefficients and compressibilities of liquid n-alkanes between 20 and 190°. Dissert. Abstr.

N68-19271 Texas Univ., Austin.
A SHOCK TUBE STUDY OF THE HYDROGEN–OXYGEN REACTION
Dennis Leon Ripley (Ph.D. Thesis) 1967 231 p
Available from Univ. Microfilms: HC $10.60/MF $3.00 Order No. 67-8153

A shock tube study of the hydrogen–oxygen reaction in the "high-temperature, low pressure" regime is described. Induction times to reach a specified OH concentration were determined using an improved Bi(3067) line absorption method for following the hydroxyl radical concentration and a sensitive laser–schlieren technique for accurately determining shock arrival. Induction times were measured in argon diluted mixtures having H_2/O_2 ratios from 0.1 to 10 over a temperature range from 1500°–2700°K. An extended analytical solution of the rate equations for the branching-chain reactions of the H_2–O_2 reaction under shock tube condtions is presented. This solution allowed quantitative comparison of calculated and experimental ignition delays. The exchange initiation reaction was found to be essential. However, a conventional reaction scheme did not give complete agreement with experimental results over the wide range of conditions studied.
Dissert. Abstr.

N68-19287 Texas Univ., Austin.
THE ELECTROLYSIS OF AMMONIUM BIFLUORIDE IN ANHYDROUS HYDROGEN FLUORIDE
Larry Gene Spears (Ph.D. Thesis) 1967 88 p
Available from Univ. Microfilms: HC $4.60/MF $3.00 Order No. 67-8159

An attempt was made to determine the electrochemical mechanism involved in the anodic fluorination of ammonia dissolved in AHF. Electrochemical techniques employed in this investigation included conductivity measurements, fast and slow sweep potentiometry, chronopotentiometry and pulse techniques. Methods used in analyzing the electrolysis products were gas chromatography and infrared and mass spectroscopy. All electrolytic cells, valves, tubing and fittings which came in contact with the HF were constructed of either Kel-F or Teflon. The working electrode (anode) used for this study was a 1/8"-diameter rod of Monel (alloy No. 400). A nickel screen was used as a cathode and an Hg/Hg_2F_2 electrode was developed and used as a reference electrode. It was concluded that the fluorination of NH_3 dissolved in AHF occurs by a radical mechanism involving anodically generated fluorine. Data taken during this study indicate that the fluorinating agent is a "loose complex" between F and NiF_2 and/or CuF_2.
Dissert. Abstr.

N68-19294 Texas Univ., Austin.
A MICROWAVE STUDY OF NITROSOMETHANE
Dewitt Coffey, Jr. (Ph.D. Thesis) 1967 97 p
Available from Univ. Microfilms: HC $5.00/MF $3.00 Order No. 67-8096

The microwave spectra of nitrosomethane and trideuteronitrosomethane have been observed and have been used to obtain values for the rotational constants, the height of the barrier to internal rotation, the quadrupole coupling constants and the components of the dipole moment along the principal axes. The transitions which have been studied all belong to the ground vibrational state, and with the exception of three transitions at somewhat higher frequencies they lie in the 8-26.5 Gc/sec region. Analysis of all the data was performed by least square fitting the theoretical parameters to the data. A computer program which calculates rotation–internal rotation spectra by the internal axis method (IAM) of Hecht and Dennison is described and comparisons with other calculation methods are presented. In particular the effect of the torsional integrals in the harmonic oscillator approximation has been investigated. A simple, approximate method is given for introducing this effect into IAM calculations which have used the infinite barrier limits. The torsional integrals are shown to affect not only the frequences of the A symmetry transitions but also the A-E splittings.
Dissert. Abstr.

N68-19339# Technische Hochschule Munchen (West Germany).
KINETIC RESEARCH ON SUBSTITUTED NITRO-BENZENE RADICAL ANIONS USING ELECTRON SPIN RESONANCE [KINETISCHE UNTERSUCHUNGEN AN SUBSTITUIERTEN NITROBENZOLRADIKALANIONEN MIT HILFE DER ELEKTRONENSPINRESONANZ]
Wolfgang Harald Wirths 24 Jul. 1967 73 p refs In GERMAN
CFSTI: HC $3.00/MF $0.65

Described is an arrangement which permits the transfer of sufficient and homogeneous concentrations of electrochemically produced radicals into the electron spin resonance (ESR) cavity for measuring the progress of the reaction by the stop-flow method. The time constants of this reaction were determined for nitrobenzene, p-nitrobenzoic acid, p-nitrochlorine benzene, and p-nitraniline at various H^+ and Na^+ concentrations. A correlation was found to exist between the Hammett δ values, the hyperfine structure splitting constants of the nitrogen 14 nuclei of the nitro groups, and the time constants extrapolated to $[Na^+] = 0$ and $[H^+] = 0$. The evaluated results for p-nitrobenzoic acid were used to establish a reaction scheme for the radical anions. A hyperfine structure splitting for chlorine in aqueous solution was measured for the first time in the ESR spectrum of the p-nitrochlorine benzene radical anion.
Transl. by K.W.

N68-19371# Technische Hochschule Munchen (West Germany).
RESEARCH ON CHROMIUM OXIDE YIELD OF POLYMERIZATION CATALYSTS [UNTERSUCHUNGEN UEBER CHROMOXIDHALTIGE POLYMERISATIONS-KATALYSATOREN]
Johann Nickl (Ph.D. Thesis)
1967 95 p refs In GERMAN

The standard processes of polyethylene synthesis were analyzed for composition of catalysts and their effects during polymerization. Physical and chemical methods were employed in the investigation. Parameters were varied with each step of the experimental procedures, among them: (1) variation in the analytical composition and the thermal treatment of the carriers; (2) use of CrO_3, $(NH_4)_2Cr_2O_7$, or Cr^{3+} solutions as fillers as well as different methods of application; (3) variation of the activation atmosphere, use of reduction gases, and variation of reaction temperature and duration; (4) reduction with different reactants; and (5) variation of temperature, ethylene pressure, time, and mechanical arrangements during polymerization. The resulting products were evaluated by chemical analysis, surface inspection, reflex and electron paramagnetic resonance spectroscopy, and kinetic measurements.
Transl. by K.W.

N68-19378 Texas Univ., Austin.
A PROTON MAGNETIC RESONANCE STUDY OF HYDROGEN BONDING IN ALIPHATIC SECONDARY AMINES
Ruth Ann Cook Murphy (Ph.D. Thesis) 1967 89 p
Available from Univ. Microfilms: HC $4.60/MF $3.00 Order No. 67-8139

Measurements at 60 Mc of the chemical shift of the N–H protons of the compounds diethylamine, di-n-propylamine, di-n-butylamine, di-i-butylamine, piperidine, and 2-pipecoline have been made as a function of concentration in cyclohexane. These data have been obtained at three temperatures for piperidine and the di-n-propyl and di-butyl amines. Di-i-propylamine could not be studied in this manner because of difficulty in observing its N–H proton signal. A possible cause of this effect is exchange broadening. The NMR spectra of all of the amines mentioned are included. Values for the chemical shift of the nonassociated N–H proton were obtained, as well as values for the product of the equilibrium constant for dimerization and the difference in shifts of the associated and nonassociated protons. Methods for the determination of independent values of the equilibrium constant and the chemical shift of the associated protons were tried with limited success.
Dissert. Abstr.

N68-19384# Technische Hochschule Munchen (West Germany).
ON THE REPRESENTATION AND REACTIVITY OF 5/6 RING AND 5/7 RING AROMATIC METAL π COMPLEXES OF MOLYBDENUM, TUNGSTEN, AND RHENIUM [ZUR DARSTELLUNG UND REAKTIVITAET VON 5-/6-RING- UND 5-/7-RING-AROMATEN-METALL-π-KOMPLEXEN DES MOLYBDAENS, WOLFRAMS UND RHENIUMS]
Hermann Wolfgang Wehner (Ph.D. Thesis) [1967] 91 p refs In GERMAN

Proceeding from metal halogenices and the corresponding olefins, it was possible to prepare 5/6 and 5/7 ring complexes of molybdenum, tungsten, and rhenium in Grignard reactions according to $MCl_x + C_7H_8 - (1.3)'C_5H_5MgBr \rightarrow C_5H_5M(H)C_6H_6$ (M = Mo, W, Re) and $MCl_x + C_7H_8 + C_5H_5MgBr \rightarrow C_5H_5MC_7H_7$ (M = Mo, W). Ultraviolet radiation was not used, and short reaction times proved advantageous. The resulting major products in all cases were the customary di-cyclopentadienyl metal hydrides $(C_5H_5)_2MoH_2$, $(C_5H_5)_2WH_2$, and $(C_5H_5)_2ReH$. Transl. by K.W.

N68-19393# Technische Hochschule Munchen (West Germany).
PHOTOCHEMICAL AND REDOX PROCESSES ON CADMIUM SULFIDE ELECTRODES [PHOTOCHEMISCHE UND REDOX PROZESSE AN CADMIUMSULFID ELEKTRODEN]
Rolf Haberkorn 1967 56 p In GERMAN
CFSTI: HC $3.00/MF $0.65

Experiments were conducted to study the corrosion behavior, the anodic and cathodic reaction mechanisms, and the crystal dissociation of cadmium sulfide electrodes. The formation of H_2 and Cd surface films and effects on cathode reactions were observed. Increase of the dark current by means of long-wave radiation whose energy is insufficient for the formation of electron–hole pairs is discussed, and several experiments are described in which the anodic limiting current is increased or even doubled by adding alcohol, formaldehyde, or formic acid to the electrolytes. The results are indicative of the function of valence or conductance electrons in the reaction. Some results are also presented of the reduction of $K_3Fe(CN)_6$ on CdS and of the electron transfer between electrode and redox electrolyte. Transl. by K.W.

N68-19434*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
RADIATION-INDUCED REDUCTION OF DIVALENT COPPER SALTS IN SOLUTIONS
Warren H. Philipp and Stanley J. Marsik Washington Mar. 1968 17 p refs
(NASA-TN-D-4451) CFSTI: HC $3.00/MF $0.65 CSCL 07C

Aqueous solutions of divalent copper salts containing soluble organic compounds were irradiated with 2-million-volt electrons. In the presence of oxidizable organic compounds (e.g., methanol, glycerine, and formaldehyde), the divalent copper ion is reduced on irradiation. From solutions of either copper(II) sulfate or copper(II) perchlorate, free copper forms. G(Cu) (atoms per 100 eV or 1.6×10^{-17} J) = 2.2. A study involving concentration parameters in the copper(II)-sulfate-methanol-water system showed that two reaction mechanisms are operative. In general, when the water is the major constituent, the initial and rate-controlling reaction is the decomposition of water by radiation to form hydrogen atoms and hydroxyl radicals. The methanol is rapidly oxidized by the hydroxyl radicals and thereby leaves an excess of reducing hydrogen radicals in the system. At high methanol concentrations, the initial process is the direct interaction of the radiation with the methanol molecules, which results in the removal of hydrogen atoms from the carbon atoms. In both mechanisms, these hydrogen atoms then reduce the divalent copper. Author

N68-19476# Foersvarets Forskningsanstalt, Stockholm (Sweden).
THE SEPARATION OF FLUORINE BY WILLARD-WINTER DISTILLATION AND ITS DETERMINATION BY TITRATION WITH THORIUM NITRATE OR BY SPECTROPHOTOMETRIC MEASUREMENT
Lars Henrik Anderson and Birgit Gelin Nov. 1967 5 p refs (FOA-4, V. 1)

The method introduced by Willard and Winter in 1933 for the separation of fluorine by distillation does not give satisfactory results in the presence of metals forming strong complexes with fluoride ions. By the use of impure chemicals or by dissolution from the glass walls of the distillation apparatus, traces of such metals may be introduced during the separation procedure, preventing complete recovery of the fluorine. When purified chemicals and a distillation apparatus made of fused silica were used, separations with recoveries around 99.5 per cent of the added amount of fluorine were possible. Aluminum prevents complete separation, as do uranium and plutonium in low valence states. Interference from the two latter elements can, however, be eliminated by oxidation to U(VI) and Pu(VI), respectively. Author

N68-19483*# National Aeronautics and Space Administration, Washington, D. C.
ANHYDROUS CALCIUM DIOXIDE AND THE CONSTITUTION OF ITS HYDRATES [SUR LE BIOXYDE DE CALCIUM ANHYDRE ET LA CONSTITUTION DE SES HYDRATES]
DE Forcrand Mar. 1968 5 p refs Transl. into ENGLISH from Compt. Rend., v. 130, 1900 p 1388–1391
(NASA-TT-F-11619) CFSTI: HC $3.00/MF $0.65 CSCL 07B

Anhydrous CaO_2 is dissolved in HCl to determine the heat of solution. The stability and heat of formation of CaO_2 and its hydrates are determined, and compared to analogous compounds of strontium and barium. Author

07 COMMUNICATIONS

Includes communications equipment and techniques; noise; radio and communications blackout; modulation telemetry; tracking radar and optical observation; and wave propagation. For basic research see: 23 Physics, General; and 21 Navigation.

N68-18293# Syracuse Univ. Research Inst., N. Y. Dept. of Electrical Engineering.
OPTIMIZATION OF PERFORMANCE INDICES IN DISCRETE ARRAY SYSTEMS Final Report, Nov. 1965–Nov. 1967
David K. Cheng 30 Nov. 1967 43 p refs
(Contract AF 19(628)-5668)
(AFCRL-67-0650; AD-664082) CFSTI: HC $3.00/MF $0.65

A basic theorem useful for the optimization of the performance indices of arbitrary antenna arrays is first reviewed. It is then applied to a general, three-dimensional array. In particular, it is specialized to determine the maximum obtainable directive gain and the main-beam radiation efficiency for circular and elliptical arrays. The gain optimization principle is also extended to arrays responding to quasi-monochromatic periodic signals and to arrays which are subject to random errors in excitation amplitudes and phases and in element positions. When the performance index of interest is the output signal-to-noise power ratio, consideration must be given to the power spectral densities of both the signal and the noise, the noise spatial distribution, the antenna space-frequency response function, the system internal noise, and the transfer function of the linear processor. The procedure for the maximization of the output signal-to-noise power ratio of an array of an arbitrary geometrical configuration when there are random variations in the design parameters is also reviewed. Author (TAB)

N68-18306# Aerospace Corp., El Segundo, Calif. Lab. Operations.
SIGNAL ENERGY DISTRIBUTION IN TIME AND FREQUENCY, 1 OCTOBER 1966–1 OCTOBER 1967
A. W. Rihaczek Oct. 1967 29 p refs
(Contract F04695-67-C-0158)
(TR-0158(3230-46)-5; SAMSO-TR-67-111; AD-664326)

The Fourier representation of signals and its relation to the signal structure in time and frequency, and more generally the inherent properties of phase-modulated signals, have received considerable attention in the past. These topics have led to such seemingly unrelated studies as the representation of a signal in a combined time-frequency plane, instantaneous power spectra, and the ambiguity function and its transform relations. It is shown in this paper that the studies can be unified by the introduction of the concept of the complex energy density function of a signal. The function is an extension and combination of the one-dimensional energy density functions in time and frequency, the energy density spectrum (the absolute value of psi(f)) squared, and energy density waveform (the absolute value of psi(t)) squared. On the basis of the complex energy density function, the significance of complicated-appearing transform relations is readily understood. The new concept also conveys a good insight into the internal structure of phase-modulated signals. Author (TAB)

N68-18310# Georgia Inst. of Tech., Atlanta. Engineering Experiment Station.
ELECTROMAGNETIC INTERFERENCE MEASUREMENT METHODS—SHIELDED ENCLOSURE Final Report, 1 Jun. 1966–31 Jul. 1967
William R. Free, Robert E. Gibson, Bernard M. Jenkins, Charles W. Stuckey, and James C. Toler Dec. 1967 96 p refs
(Contract DA-28-043-AMC-02381(E))
(A-945-F; Rept.-36; ECOM-02381-F; AD-664159)

The report summarizes the accomplishments on a program to develop test techniques and procedures for making radiated measurements in shielded enclosures which can be correlated with open-field measurements. A technique of shielding the probe antenna in all directions except that of the desired signal path by means of a metal hood lined with absorbing material was developed. An evaluation indicated that, over the frequency range from 200 MHz to 12 GHz, the technique is capable of reducing the multipath reflections in shielded enclosures to a level comparable with the reflections normally encountered in open-field measurements. The development, fabrication and evaluation of two hooded probe antennas covering the frequency range from 200 MHz to 12 GHz are described. The field-intensity calibration of the two hooded probe antennas is also described. At lower frequencies where the shielded enclosure dimensions and probe antenna spacings are small relative to the wave lengths involved, tests which correlate with open-field measurements can be made. In order to establish the critical or upper limit frequency for this low frequency range, theoretical and experimental studies were conducted to investigate the field distributions within shielded enclosures at low frequencies. These studies established that satisfactory measurements can be made with conventional probe antennas in the frequency range from 1 to 30 MHz. Author (TAB)

N68-18321# Mitre Corp., Bedford, Mass.
NUMERICAL INTEGRATION OF BAND LIMITED SIGNALS WITH APPLICATIONS TO COMPUTER IMPLEMENTED SIGNAL PROCESSING
John T. Lynch Dec. 1967 31 p ref
(Contract AF 19(628)-5165)
(MTR-473; ESD-TR-67-424; AD-664569) CFSTI: HC $3.00/MF $0.65

In many computer-implemented signal-processing systems, it is necessary to perform numerical integrations. If the function to be integrated is a band-limited time signal represented by a set of samples, serious distortion can occur if the wrong integration technique is used. In particular, if the integration is used to calculate a Fourier transform, large error side-lobes will be introduced if Simpsons rule or other higher-order rules are used. It is shown that the rectangular rule introduces no distortion and gives a result which is consistent with the number of samples. Author (TAB)

N68-18332# Mitre Corp., Bedford, Mass.
POLARIZATION PROPERTIES OF THE PARABOLOIDAL ANTENNA: AN ANALYTICAL STUDY
Jerome L. Altman Dec. 1967 211 p refs
(Contract AF 19(628)-5165; Proj. Defender)
(MTP-52; ESD-TR-67-425; AD-664564)

The study is a theoretical investigation of the polarization properties of the paraboloidal antenna for both the focal feed system and the Cassegrain feed system when the feed horn is either circularly or linearly polarized. The properties are analyzed in terms of general analytic equations and also in terms of quantitative graphs pertaining to the specific case of a 30-foot diameter paraboloidal antenna. Author (TAB)

N68-18334# Harvard Univ., Cambridge, Mass. Cruft Lab.
INFINITE PHASED DIPOLE ARRAY
V. W. H. Chang Dec. 1967 44 p refs
(Contract AF 19(628)-2408)
(SR-21; AFCRL-67-0653; AD-664064)

By means of the Poisson sum formula and an integral-equation technique an accurate solution for an infinite phased dipole array is obtained. The elements of the array are spaced uniformly and are excited with progressively increasing phases. The technique can be applied to an infinite collinear array and to an infinite planar array either in free space or over a ground plane. The integral equation is solved both by a Fourier method and by an approximate five-term procedure. It is found that the latter is as good as the former. The current distributions and the active admittances are investigated. Author (TAB)

N68-18344# Lincoln Lab., Mass. Inst. of Tech., Lexington.
X-BAND CYLINDRICAL LENS ANTENNA
A. Sotiropoulos 26 Oct. 1967 33 p refs
(Contract AF 19(628)-5167)
(ESD-TR-67-548; TN-1967-47; AD-664570)

The report describes a low-silhouette X-band circularly polarized airborne antenna. The antenna system consists of a solid polyethylene cylindrical lens and a circular polarization transducer illuminated by a line source. Author (TAB)

N68-18349# Advanced Technology Corp., Timonium, Md.
RESEARCH STUDY INTO THE NEAR EARTH APPLICATION OF MILLIMETER RADIO WAVES AS APPLIED TO CERTAIN BATTLEFIELD PROBLEMS
John M. Cotton, Jr. 15 Dec. 1967 27 p refs
(Contract DA-18-001-AMC-829(X))
(AD-664175)

The report describes the design of a 35 GHz solid state source. A unique feature of the source is a linear FM capability of 350 MHz at sweep rates from 5 Hz to greater than 20 kHz. The output power is approximately 50 mW. Frequency stability is derived from an 81 MHz crystal controlled oscillator. Transistor circuitry brings this signal up to 324 MHz at 9 watts. A varactor multiplier chain then is used to achieve the final output frequency. Author (TAB)

N68-18355# Radiation, Inc., Melbourne, Fla.
INVESTIGATION OF CHAFF COMMUNICATIONS AT 4,650 MHZ Final Report, 1 Jun. 1966–15 Jun. 1967
R. E. Totty, G. C. Clark, D. D. McRae, R. C. Davis, A. M. Bush et al Aug. 1967 319 p refs
(Contract DA-28-043-AMC-00202(E))
(ECOM-0202-3; FR-3; AD-664124)

The purpose of Task IV was to obtain more experimental data on the behavior and parameters of a falling chaff communication channel especially at high altitudes (60-114 thousand feet), and to investigate those problem areas uncovered in Task III. The experimental work was performed at a frequency of 4650 MHz. Estimated coherent bandwidths on the order of 0.5-2 MHz, and fading bandwidth on the order of 5-40 Hz were observed. Drift rates and fall rates varied over a wide range depending on the point of deployment. Deployment altitudes in the vicinity of 65 thousand feet provided longer communication time than deployment at other altitudes. Theoretical studies include the effect of frequency separation in binary FSK, performance of error correcting codes with varying interleaving distances in a fading channel, influence of bit synchronization in a fading channel, and analysis of distortion in frequency selective channels including estimates of Noise Power Ratio (NPR). Author (TAB)

N68-18380# Naval Research Lab., Washington, D. C. Radar Div.

LARGE ANTENNA SYSTEMS

Merrill I. Skolnik. 29 Dec. 1967. 54 p refs

(NRL-6628; AD-664462) CFSTI: HC $3.00/MF $0.65

Large antennas are of importance in radar, communications, and radio astronomy applications where sensitivity and/or angular resolutions are important. However, several major limitations exist to the achievement of large size antennas. Among the limitations are mechanical and environmental factors, measurement limitations, spatial bandwidth, and the effects of random errors. Mechanical factors seem to limit the tolerance achievable in present practical antennas to about one part in 10,000 more or less. This tolerance results in an antenna size of less than 400 wavelengths, corresponding to beamwidths of about 1/6 degree. Larger antennas are possible, but usually with degraded performance. Many of the limitations due to the environment can be overcome by operation inside a radome, although the radome itself will impose a limit on the antenna size. Several common antenna types can be constructed in large sizes. The parabolic reflector in one of its many forms is the most common example of large antennas, whether movable or fixed. Array antennas with low gain elements are expensive in large sizes because of the large number of elements that they must contain. However, arraying of a modest number of large directive antennas is an attractive method for achieving large aperture and is widely employed by the radio astronomer. Aperture synthesis as practiced by the radio astonomer and synthetic aperture as employed by the radar engineer are methods for achieving the effect of a large antenna by time-sharing an aperture of modest or small size. Author (TAB)

N68-18387# Parke Mathematical Labs., Inc., Carlisle, Mass.

A FAMILY OF CODES FOR THE CORRECTION OF SUBSTITUTION AND SYNCHRONIZATION ERRORS

L. Calabi and W. E. Hartnett. Oct. 1967. 15 p refs

(Contract F19628-67-C-0030)

(AFCRL-67-0591; SR-3; AD-664579)

The paper presents a family of binary block codes which are decodable in the presence of certain errors. The allowable errors are: for each $t = \text{or} > 3$ consecutive words, either one synchronization error (loss or gain of digit) or one substitution error in each of (t-2) words but not both. Author (TAB)

N68-18396# Analysis and Computer Systems, Inc., Burlington, Mass.

SATELLITE DATA REDUCTION PROCESSOR SYSTEM (SADAR)

John A. Fusco and Walter J. Paige. Oct. 1967. 61 p refs

(Contract F19628-67-C-0125)

(AFCRL-67-0561; SR-1; AD-664349)

This report describes the analysis, design and programming tasks necessary to develop a data processing and analytical programming system capable of processing information from a broad class of rockets and satellites launched as part of the AFCRL research and development mission. The Satellite Data Reduction Processor System (SADAR) described in this report is a programming system capable of processing recorded data from spacecraft with minimum change from vehicle to vehicle. Presented herein are the concepts required for such a system, and the steps necessary for their implementation into a flexible, efficient programming system. The SADAR system is the result of a detailed analysis of programs presently being utilized for satellite data reduction purposes and a thorough investigation of the design and objectives of future vehicles and their instrumentation packages. SADAR incorporates the best features of the satellite data processing field with new concepts proposed for system flexibility and capability.

Author (TAB)

N68-18425# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.

RADAR TRACKING ANOMALIES OVER AN ARID INTERIOR BASIN

B. D. Hinds. Aug. 1967. 41 p refs

(ECOM-5140; AD-664112)

Ground based radars tracked an aircraft flying selected patterns between 1,000 and 4,000 feet over an ephemeral lake (25 miles north of the radars) from September 1963 to February 1964. Approximately 50% of the 83 missions, skin, s-band passive target tracking, and/or c-band active target tracking radars, indicated propagational anomalies. This report discusses the instrumentation, tracking loss characteristics, and attendant meteorological conditions and presents a detailed examination of tracking losses observed on 6 November 1963. This study also indicates that a 10N unit inhomogeneity gradient was formed by a perturbated thermal condition to defocus the tracking radars by multipath propagation. Author (TAB)

N68-18542*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

WAVEFORM DISTORTION IN A MAXIMUM-LIKELIHOOD DARLINGTON DETECTOR FOR M-ARY PFM SIGNALS

Paul J. Heffernan. Washington, Mar. 1968. 36 p refs

(NASA-TN-D-4294) CFSTI: HC $3.00/MF $0.65 CSCL 09F

This paper describes a proposed pulse frequency modulation digital communication system for satellite applications. The heart of the proposed system is a maximum-likelihood detector of the spectrum-analysis type discussed by Darlington. It is shown that the proposed technique is in principle an ideal M-ary system. A general description is followed by an analysis of anticipated departures from the theoretic system—in particular, waveform distortion due to finite bandwidth, slope mismatch, and phase and amplitude ripple. General results are derived, from which permissible tolerances for departures from the theoretical system may be computed. Author

N68-18543*# Melpar, Inc., Falls Church, Va.

THIN-FILM PERSONAL COMMUNICATIONS AND TELEMETRY SYSTEM (TFPCTS), PHASE B Quarterly Report, 24 Jun.–24 Sep. 1966

Oct. 1966. 37 p

(Contract NAS9-3924)

(NASA-CR-65989; QR-2) CFSTI: HC $3.00/MF $0.65 CSCL 09F

In continuing research on the development of a thin film personal communication and telemetry system, research centered on the reduction of as many circuits as possible to a thin film design. The circuits considered include transmitter audio amplifier module, lowpass filter module, voltage controlled oscillators (VCO), twin-T filter module, summing network module, and the operational amplifier. Tables are included that show the process steps and tolerances involved in the fabrication of the VCO diplexer and twin-T filter substrates. Charts are given which completely define the

circuits in terms of the material used for the resistors, capacitors and conductors, and the resistivities, capacitances per unit area, and deposition thicknesses. B.S.D.

N68-18581# Joint Publications Research Service, Washington, D. C.

A CLASS OF INFORMATION PROCESSING PROBLEMS AT THE OUTPUT OF A COMMUNICATION LINE

V. P. Zelenen'kiy *In its* Tech. Cybernetics 5 Mar. 1968 p 60–69 refs (See N68-18577 09-19)

Methods of applying the theory of statistical solutions to the problem of determination of the times signals are sent over a communication line in the presence of noise are investigated. Algorithms are obtained for processing the information at the end of the communication line, and methods of evaluating the accuracy of the results obtained are given. Author

N68-18596# Joint Publications Research Service, Washington, D. C.

CALCULATING THE REACTION OF DENSE COMPOUND FILTERS TO SMOOTH SIGNALS

R. S. Protopopov *In its* Tech. Cybernetics 5 Mar. 1968 p 222–235 (See N68-18577 09-19)

General formulas are obtained for calculating the output effect of a filter the pulse characteristic of which consists of a number of partial characteristics under the effect of a signal described by a continuous function while it lasts. Formulas are also obtained for calculation of the output effect of this filter the pulse characteristic of which is described by a continuous function during the time of its existence under the effect of a signal consisting of a number of samples. The results obtained simplify the calculation of the output effect in the case of discrete signals and filters widely used in modern information transmission, processing and storage systems. Author

N68-18616*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

A QUASI-OMNIDIRECTIONAL SLOT ARRAY ANTENNA FOR SPACECRAFT USE AT MICROWAVE FREQUENCIES

W. F. Croswell, C. M. Knop, and D. M. Hatcher Washington Mar. 1968 60 p refs

(NASA-TN-D-4362) CFSTI: HC $3.00/MF $0.65 CSCL 09F

The theory, design, and development of a resonant array of circumferential shunt slots cut in the broad wall of a ring waveguide, which is recessed into a circular metallic cylinder and dielectric coated in the recessed region, are presented. This antenna is suitable for narrow bandwidth space-vehicle applications, since it is essentially flush mounted, provides nearly omnidirectional coverage in the plane perpendicular to the vehicle axis, and provides a broad pattern in the planes which are parallel to and pass through this axis. The theory used for the design of the array is based upon the approximate synthesis method of Knudsen and Chu, in conjunction with the work of Wait for slots on dielectric-coated cylinders. The tolerance problems encountered in the development of the array and their solutions are discussed. Author

N68-18618# Institute for Defense Analyses, Arlington, Va. Science and Technology Div.

SOME DESIGN CONSIDERATIONS FOR DIGITAL TRACKING FILTERS

Kenneth Steiglitz Dec. 1967 34 p refs

(Contract DAHC15-67-C-0011)

(IDA/HQ-67-6715; P-364; AD-664486) CFSTI: HC $3.00/MF $0.65

The problem of how best to operate on sampled data to smooth and predict a polynomial corrupted by noise has received much attention. Finite memory and recursive filters have been studied. In this paper the weighting sequences for both are derived in the same notation, by designing the filters according to the criterion of minimizing the square error weighted by a function of the age of the data. When the age-weighting function is truncated, the filters become finite memory; when the age-weighting function is exponentially decaying, recursive filters result. Expressions are then derived in this uniform notation for the random error due to white measurement noise; and the systematic error, which arises because the actual track is assumed to be a higher order polynomial than the model. The random error increases with the model order m and decreases with the memory length, while the reverse is true for the systematic error. Thus numerical evaluation of these expressions provides some basis for the choice of memory length, model order, and filter type for the filtering of polynomials. The results of some explicit calculations are given for finite memory and recursive filters, one-step-ahead prediction, cubic actual track, and linear and quadratic models. Author (TAB)

N68-18664*# Thiokol Chemical Corp., Huntsville, Ala.

RADAR ATTENUATION MEASUREMENTS Final Report, 16 Nov. 1964–15 May 1965

G. W. Sanford 14 May 1965 52 p refs

(Contract NAS8-11635)

(NASA-CR-61625; Rept.-34-65) CFSTI: HC $3.00/MF $0.65 CSCL 09F

Eight rocket motors (two TX-280, three 2KS36 Genie, and three TE-29 Recruit) were static tested to determine the extent of radio interference produced by the ionized exhaust gases just aft of the nozzle exit plane. Attenuation measurements were made on the X (10 KMC), Ku (20 KMC) and Ka (30 KMC) bands. Data were recorded on FM tape and oscillograph traces in all tests. A review of these records indicates that, for all motors, attenuation during motor operating time was essentially below 0.25 db, which is considered the resolution capability of the system. Attenuation peaks were encountered in all motors during ignition and, to a lesser degree, during motor tail-off. The theoretical calculations of attenuation levels made prior to the tests indicated a very low attenuation during motor operating time. This prediction was essentially confirmed by the actual test data. Author

N68-18703*# National Aeronautics and Space Administration. Electronics Research Center, Cambridge, Mass.

ATTENUATION AND DISPERSION OF LONGITUDINAL WAVES IN VISCOUS, PARTLY IONIZED GASES

David Kahn Washington Mar. 1968 9 p refs

(NASA-TM-X-1458) CFSTI: HC $3.00/MF $0.65 CSCL 20I

The propagation of longitudinal waves in three fluid, partly ionized gases is studied as a function of the collision and plasma-to-wave-frequency ratios. A collisional approach is taken with the full Boltzmann equations (together with Maxwell's equations) serving as the starting point, the intention being to describe wave dispersion and absorption in the collisional regime, and to include the viscous and heat conduction effects on the wave propagation from the beginning as an integral part of the theory. Author

N68-18780*# Melpar, Inc., Falls Church, Va.

THIN FILM PERSONAL COMMUNICATIONS AND TELEMETRY SYSTEM (TFPCTS), PHASE C Quarterly Report, 24 Mar.–24 Jun. 1967

Jul. 1967 15 p

(Contract NAS9-3924)

(NASA-CR-65988; QR-1) CFSTI: HC $3.00/MF $0.65 CSCL 09F

The objective of the contract is to design and construct a thin-film personal communication and telemetry system. The objective is to package two transceivers using the modules developed in Phase B of the program. These modules are now being constructed. The evaluation process on the universal RF module has been very gratifying. A number of these modules have been fabricated and their performance has been excellent in regard to power gain and stability. One IF substrate is partially assembled and

appears to function properly. A preliminary system package has been designed and the estimated volume of 10 cubic inches seems reasonable. All of the RF circuitry can be packaged in 4.5 cubic inches since each transmitter and receiver will be approximately 3/8"×1"×3". These dimensions include all of the shielding necessary to assure proper system operation. Author

N68-18803# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CERTAIN METHODS OF PRIMARY TREATMENT OF SOUND INFORMATION [NEKOTORYYE METODY PERVICHNOY OBRABOTKI ZVUKOVOY INFORMATSII]
V. G. Zaytsev *In its* Cybernetics and Computer Technol. 31 Mar. 1967 p 76–81 refs (See N68-18793 09-10)

Consideration is given to the preliminary treatment of sound signals (speech) so that the information contained in the signals can be deciphered and fed into a computer. The spectral characteristics of a signal are determined by electrical filters (usually 8–12), the obtained spectrum is presented in discrete form and it is subjected to further treatment in the computer. It is desirable to produce an undistorted picture of the spectrum for speech type signals, one that varies over time. An effective phase filter for analyzing sounds that consist of attenuating frequency components can be constructed by sending a damped oscillation to the circuit; the change in phase with frequency will be sharper in the resonance area if the input oscillation is attenuating than if it were constant or increasing in amplitude. such a filter is described and analyzed. Author

N68-18806# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
QUESTION OF AUTOMATIC TREATMENT OF SOUND INFORMATION [K VOPROSU AVTOMATICHESKOY OBRABOTKI ZVUKOVOY INFORMATSII]
V. G. Zaytsev *In its* Cybernetics and Computer Technol. 31 Mar. 1967 p 97–107 refs (See N68-18793 09-10)

After analyzing the structure and function of the human ear, hearing theories are considered. The functioning of the human ear, through mathematical analysis, can be used as the basis for constructing a device to be a buffer stage between sound signals and a computer. This buffer stage will systematize and preliminarily process the incoming information, decreasing its volume and giving it a form convenient for direct lead-in into the computer. Author

N68-18953* Purdue Univ., Lafayette, Ind. School of Electrical Engineering.
ADAPTIVE DETECTION OF NON-SYNCHRONOUS SIGNALS
T. L. Stewart and J. C. Hancock [1966] 16 p refs Presented at the Intern. Symp. on Inform. Theory, Los Angeles, 31 Jan.–2 Feb. 1966
(Grant NsG-553)
(NASA-CR-69933) CSCL 09F

An approach is presented for determining the receiver synchronization for the m-ary adaptive decision problem. The formulation is optimum in the sense that the risk associated with choosing the incorrect synchronization time is minimized after each baud is received. The approach allows the system to adapt to the correct time while taking into account any a priori information regarding the synchronization time or the signal parameters. The system adapts without the use of any auxiliary synchronization signal, which is important in communication systems in which the transmitter may be restricted as to size, complexity, and output power capabilities. Author

N68-18979*# Boeing Co., Seattle, Wash. Space Div.
DEVELOPMENT OF CHECKOUT SPECIFICATIONS FOR NEW TELEMETER SYSTEMS, PHASE B
R. W. Ekis 5 Mar. 1968 111 p refs
(Contract NAS8-21205)
(NASA-CR-61586; D5-13402-1) CFSTI: HC $3.00/MF $0.65 CSCL 09F

The scope of this contract includes the study, compilation, evaluation and development of checkout specifications for new data transmission techniques, new telemeter proportional bandwidth channels, constant bandwidth systems, higher transmission frequencies and other advanced telemetry techniques, and for the post-manufacturing and prelaunch checkout equipment. Phase A consisted of a survey of new and proposed telemeter systems and techniques and for the preparation of a short description of each. The intent of Phase B is to determine the following in regard to the systems approved by the customer: parameters to be measured to assure flight readiness; any peculiarities requiring special checkout data to be taken at the subsystem test level; if available standards sufficiently control development and implementation; and, if the developers' ground equipment is adequate for post-manufacturing and prelaunch checkout. Author

N68-19089*# Raytheon Co., Norwood, Mass. Equipment Div.
A FEASIBILITY STUDY OF SIGNAL PROCESSING TO IMPROVE ANTENNA GAIN Final Report
R. G. Cease, C. K. H. Tsao, W. J. Bickford, and H. J. Rowland Nov. 1967 56 p refs
(Contract NAS12-529)
(NASA-CR-86038; CDP-TR-4) CFSTI: HC $3.00/MF $0.65 CSCL 09F

A signal processor, employing a synthetic phase isolator (SPI), has been investigated analytically and experimentally for application in an adaptive antenna array which is illuminated simultaneously by a coherent signal source and a partially coherent interfering source. The performance of the signal processing array is discussed in terms of processing gain and tracking error. It is shown that, when the partially coherent interfering source has large angular extent relative to the theoretical plane wave beamwidth of the antenna array, large processing gain is achieved. For a nearly coherent interfering source, the performance of the array exhibits a "capturing effect" as in an FM receiver. That is, the adaptive array tends to form a beam in the direction of the stronger of the two sources. The amount of discrimination against the weaker source depends on, but not entirely, the "pattern factor" of the array. Author

N68-19081*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
DESIGN AND CALIBRATION OF LOW FREQUENCY RADIO ASTRONOMY SPACE PROBES
Richard R. Weber Feb. 1968 38 p refs
(NASA-TM-X-63129; X-615-68-73) CFSTI: HC $3.00/MF $0.65 CSCL 09F

A study is made of the criteria to be used in designing a low frequency space probe. An optimizing procedure is detailed. Frequencies to be observed are set by magnetoionic parameters encountered in the flight. Dipole antennas are discussed and it is shown that longer dipoles are generally desirable. Receiver types are described. Receiver input impedance is discussed. It is shown that high impedance receivers are preferable unless sensitivity is a serious problem. It is shown that a moderate imbalance in a balanced high impedance receiver can be neglected. A calibration method is outlined. Dummy antennas are used to represent the flight antenna. The dummy antenna parameters are discussed. Receiver impedance measurements are discussed. Author

N68-19090# RAND Corp., Santa Monica, Calif.
SOME REMARKS ON DIGITAL DISTRIBUTED COMMUNICATIONS NETWORKS
Paul Baran Jun. 1967 24 p refs Presented at the WINCON Conf., Los Angeles, 8 Feb. 1967
(P-3536; AD-654574)

The rapid evolution in the design of communication networks makes it possible to create new communications networks more reliable than the reliability of the links themselves. This becomes possible because of the advent of new digital computer technology which allows us to physically implement switching doctrines which at an earlier date could only be of academic concern. While such switching schemes are of most interest to the military, they offer a promise for other such applications, such as data communications. Further, with the decreasing cost of digital switching and transmission, such schemes may one day even be chosen on economic grounds alone, however, the state-of-the-art of communication technology is changing so rapidly that it is foolhardy to predict the far future, but, it seems safe to say that digital communications switching and transmission has progressed so rapidly that the spectrum of possible new switching systems is still relatively unexplored. Any discussion based on a new technology inevitably raises the hoary argument of 'complexity.' These new switching techniques are, admittedly, more complex, but, the equipment required is smaller, more reliable, and requires less maintenance—although requiring more components. Author (TAB)

N68-19149*# Electro-Mechanical Research, Inc., Sarasota, Fla.
VIDEO DATA MODULATION STUDY, VOLUME 1 Final Report
J. K. Fadely, B. C. King, J. M. Knight, G. L. Raga, and A. E. Pieper 31 Jul. 1964 241 p Prepared for JPL
(Contracts NAS7-100; JPL-950705)
(NASA-CR-93568) CFSTI: HC $3.00/MF $0.65 CSCL 17B

Data are presented on several compression schemes developed to meet the gross compression or fidelity requirements for a video data modulation system. Based on these data, a modulation technique is recommended which yields a minimum data compression ratio of 2:1. Due to losses associated with compression, the gross compression must be greater than the desired net compression. Factors such as the need for additional synchronization bits and increased transmitted energy per bit which lead to compression degradation were considered, and a figure was derived for the necessary gross compression. In addition, fidelity criteria were investigated as an integral part of the data modulation study in order to optimize tradeoffs between fidelity, reliability, size, weight, and power consumption of the compression system terminal equipment. Once a system was developed which met the gross compression requirements with acceptable picture fidelity, additional studies were carried out to verify experimentally gross compression figures and fidelity expectations through the use of real pictures and computer techniques. These then led to the design of block diagram level recommendations for the selected video modulation technique. Volume 2 contains photographic plates generated in the course of the study. E.J.S.

N68-19150* Electro-Mechanical Research, Inc., Sarasota, Fla.
VIDEO DATA MODULATION STUDY: PHOTOGRAPHIC PLATES, VOLUME 2 Final Report
31 Jul. 1964 65 p Prepared for JPL For abstract, see N68-19149
(Contracts NAS7-100; JPL-950705)
(NASA-CR-93472) CSCL 17B

N68-19159*# TRW Systems Groups, Redondo Beach, Calif. Space Vehicles Div.
VOYAGE SPACECRAFT PHASE B, TASK D. VOLUME 7: PRELIMINARY OSE AND MDE Final Report
Oct. 1967 262 p
(Contract NAS8-22604)
(NASA-CR-93536) CFSTI: HC $3.00/MF $0.65 CSCL 09F

Preliminary requirements for the mission dependent equipment (MDE) and operational support equipment (OSE) necessary to support the Voyager spacecraft are defined. Functions and facilities of the mission operations complex (MOC) for the Voyager mission support are delineated. The MDE operation test and checkout equipment are presented and the electrical equipment common to both MDE and OSE is described. Mission-dependent computer program functions are discussed, along with their requirements and objectives. The electrical operational support equipment is evaluated in relation to its objectives, design criteria, functional description, and integrated systems. Functional descriptions, objectives, and functional flow charts are also included on the mission operational support equipment. B.S.D.

N68-19208*# California Computer Products, Inc., Anaheim.
MRIR PCM TELEMETRY UNIT Final Engineering Report
5 Apr. 1967 100 p refs
(Contract NAS5-10215)
(NASA-CR-93509; D0301-019) CFSTI: HC $3.00/MF $0.65 CSCL 09F

Three medium resolution infrared radiometer telemetry electronics units were fabricated and functionally tested. These units, to be used for the Nimbus C medium resolution infrared experiment, consist of one prototype and two flight qualified subassemblies. Information on the electronic and mechanical design, the qualification and system tests, and the operation and maintenance of the subsystems is included. R.N.A.

N68-19255 Texas Univ., Austin.
APPLICATION OF DIGITAL INVERSE FILTERS TO SIGNAL RESTORATION
Oran Brigham, Jr. (Ph.D. Thesis) 1967 118 p
Available from Univ. Microfilms: HC $5.80/MF $3.00 Order No. 67-8093

The application of digital inverse filters to signal restoration is developed. An optimal inverse filter is defined and an iterative technique which converges in the time domain to this solution is presented. The inverse convolution problem in the presence of noise is studied under the assumption that no "a priori" knowledge of the statistics of the noise or of the signal is known. An approximation technique, which determines the minimum number of weights and their spacing, for an inverse convolver is contributed. Dissert. Abstr.

N68-19297# Airborne Instruments Lab., Deer Park, N. Y.
PRECISION VOR. VOLUME 3: PVOR(M) MONITOR HANDBOOK Final Report
E. Hollm, R. Mesard, and M. Zeltser Aug. 1967 45 p
(Contract FA-65-WA-1058)
(RD-67-58, V. 3)

As an aid to evaluating the monitor equipment and system, details are given on the additional equipment and the modifications to existing equipment necessary to monitor the radiated signals of a precision multilobe very high frequency omnidirectional range (PVOR(M)) system. The monitor system, installed at a PVOR(M) ground station in conjunction with a modified conventional VOR monitor, detects the radiated signals at various azimuths about the station and supplies them to the conventional monitor and its own internal circuits. The circuits sense deviations in phase and amplitude of the 53 Hz PVOR(M) signals; an alarm is signaled if the deviations exceed preset values. The equipment consists of phase-lock loops to extract the precision signals, and a programmed selector unit to sequence among eight field detectors in order to detect any conceivable ground station fault. The theory of operation and installation, and adjustment and operating instructions are described. M.G.J.

N68-19298# Airborne Instruments Lab., Deer Park, N. Y.
PRECISION VOR. VOLUME 2: PVOR DIGITAL SIGNAL GENERATOR HANDBOOK Final Report

J. Lovell, E. Drogin, and B. Gold Aug. 1967 40 p
(Contract FA-65-WA-1058)
(RD-67-58, V. 2)

Operating principles and procedures are detailed on the precision very high frequency omnidirectional range (PVOR) digital signal generator, which is an audio signal generator designed for testing and calibrating PVOR converters and receivers. Digital integrated circuit techniques are incorporated in the design to achieve phase accuracy and stability. Used in conjunction with an RF signal generator, a complete PVOR or VOR signal is provided. Schematic diagrams and descriptive data are presented on the analog circuits, the digital bearing selector, the flip–flops, triple NAND gate, the binary-coded decimal stage, and the 13-speed counter and register. Calibration instructions are given. M.G.J.

N68-19383*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
IONOSPHERIC DISTORTION OF MINITRACK SIGNALS IN SOUTH AMERICA
Tom Golden Feb. 1968 37 p refs
(NASA-TM-X-63136; X-525-68-56) CFSTI: HC $3.00/MF $0.65
CSCL 17I

Records of tracking operations with the Minitrack system in South America have been compiled for a 12-month period. The number of passes scheduled and the number missed due to VHF propagation distortion have been computed in hourly increments beginning 1 July 1966. Records for Stadan tracking stations at Quito, Ecuador; Lima, Peru and Santiago, Chile show a diurnal maximum of interference close to local midnight and seasonal maxima during and immediately following the equinoxes. A similar compilation has been made of the incidence of spread echoes on ionosonde records made at nearby ionospheric sounding stations at Bogota, Colombia; Huancayo, Peru and Concepcion, Chile. A close diurnal and seasonal correlation between the NASA VHF interference data and the ESSA HF data is shown. The results of the study indicate a potential for ionospheric interference with satellite telemetry and command functions which must be performed instantaneously. Over a long period of time Minitrack orbit determination is not severely degraded by ionospheric distortion.
Author

N68-19390*# Philco Corp., Palo Alto, Calif. Space and Re-Entry Systems Div.
DESIGN STUDY OF THE JPL S-BAND TURNAROUND RANGING TRANSPONDER Final Engineering Report
1 Nov. 1967 219 p ref Prepared for JPL
(Contracts NAS7-100; JPL-951209)
(NASA-CR-93669; TR-DA1522A) CFSTI: HC $3.00/MF $0.65
CSCL 09F

The major Phase II effort was spent in a test program to evaluate and isolate the causes of S-band carrier phase shift and ranging delay variation in the Mariner C transponder, as a function of temperature. Specific diagnostic tests were also performed on several of the modules. An attempt was made to relate the ranging delay and S-band phase temperature data to transponder circuit functions. A study was also made to determine the optimum transmit-to-receive frequency ratio, from the transponder viewpoint, for the proposed change in the Deep Space Instrumentation Facility band occupancy. A new version of the video amplifier was developed.
R.N.A.

08 COMPUTERS

Includes computer operation and programming; and data processing. For basic research see: 19 Mathematics.

N68-18256# Illinois Univ., Urbana. Dept. of Computer Science.
[DEPARTMENT OF COMPUTER SCIENCE] Quarterly Technical Progress Report, Apr.–Jun. 1967
Jun. 1967 296 p refs
(Contracts AT(11-1)-1469; AF 30(602)-4144)
(COO-1469-0072; AD-664225)

Contents: Circuit research program; Hardware systems research; Software systems research program; ILLIAC IV; Numerical methods, computer arithmetic and artificial languages; Computational physics; Switching theory and logical design; ILLIAC II service, use, and program development; IBM 7094/1401 service, use, and program development; Problem specifications; General laboratory information.
TAB

N68-18271# Syracuse Univ., N. Y.
THEORY OF ADAPTIVE MECHANISMS. PART 3: APPLICATIONS OF THE ITERATIVE ARRAY COMPUTER RADCIAC. PART 4: A SUPPLEMENT TO RADICAL MANUAL Interim Report, 8 Aug. 1966–7 Aug. 1967
K. Armioto, Frank R. Moore, and Robert Cantarella Griffiss AFB, N. Y. RADC Dec. 1967 258 p refs
(Contract F30602-67-C-0011)
(RADC-TR-67-521, V. 2, Pt. 3; RADC-TR-67-521, V. 2, Pt. 4; AD-664350)

Part III - The report presents the following applications of the Iterative Array Computer RADCIAC: (1) Simulation of Analog Computers on an Iterative Array Computer, (2) Firing Squad Simulation Program, (3) Matrix Multiplication on an Iterative Array, and (4) An Iterative Array Pseudo-Random Number Generator. Part IV - The report is a supplement to the report, RADICAL Manual and Subroutines, by Frank Moore. Only fixed point subroutines were provided in that report. This supplement contains floating point subroutines of two different formats and also input-output subroutines for an on-line IBM typewriter.
TAB

N68-18272# Illinois Univ., Urbana. Dept. of Computer Science.
DEPARTMENT OF COMPUTER SCIENCE Quarterly Technical Progress Report, Jan.–Mar. 1967
Mar. 1967 296 p refs
(Contracts AT(11-1)-1469; Nonr-1834(15); Grant NSF GP-4646)
(COO-1469-0071; AD-664224)

Contents: Circuit research program; Hardware systems research; Software systems research program; ILLIAC IV; Numerical methods, computer arithmetic and artificial languages; Computational physics; Switching theory and logical design; ILLIAC II service, use, and program development; IBM 7094/1401 service, use, and program development; Problem specifications; General laboratory information.
TAB

N68-18276# Signatron, Inc., Lexington, Mass.
A BASE FOR THE DEFINITION OF COMPUTER LANGUAGES
Richard K. Bennett Oct. 1967 39 p refs
(Contract F44620-68-C-0007)
(AFOSR-68-0104; AD-664086)

The presentation investigates and describes certain promising ideas for the design of computer languages and translators. By isolating and utilizing the fundamental elements of computer languages and the fundamental mechanisms of assemblers and compilers this approach provides a very flexible and powerful base for defining languages and their translators. Throughout the approach, the users needs are emphasized in a studied and analytical manner. The approach seeks to give the user facilities that really help him and place at his command many devices and facilities which today are available only in separate, special-purpose languages. The purpose of this approach is to achieve simplification, unification, and standardization of existing languages so they may all be built on one universal base and may all be handled by one general translator. At the same time, this universal base and its translator will encourage the orderly and rapid development of many new powerful

languages tailored to special areas. These new languages would greatly reduce the programming effort required in these areas, could help solve the programming bottleneck, and could further the development of some of the really challenging applications of the digital computer. Author (TAB)

N68-18289# Naval Weapons Lab., Dahlgren, Va. Computation and Analysis Lab.

LIST FORTRAN, A BASIC LIST PROCESSING EXTENSION OF FORTRAN ON THE IBM 360

Hartmut G. M. Huber 5 Oct. 1967 54 p refs

(NWL-2123; AD-664470) CFSTI: HC $3.00/MF $0.65

FORTRAN is quite convenient for writing programs that process data of the type INTEGER, REAL, or LOGICAL, or arrays of such basic data types. The language, however, is inadequate for handling data of unpredictable length and inhomogeneous nature, normally represented as sequences of expressions built up from various basic constituents. List-FORTRAN is an extension of FORTRAN such that in addition to REAL and INTEGER data, a new data type LIST is available as an object for computation. A convenient set of operations is provided for manipulating data that are lists. They are used in the same way as any other FORTRAN subroutines or functions. The system contains both a set of general list-processing operations and an efficient rational arithmetic for arbitrary long numbers represented as lists. Administration of storage is based on automatic storage allocation using a technique known as garbage collection. It is implemented on the IBM 360 and available within the FORTRAN system under BPS. Author (TAB)

N68-18290# Naval Weapons Lab., Dahlgren. Computation and Analysis Lab.

A STRETCH COMPUTER PROGRAM TO EXTRAPOLATE HERO DATA

Harold T. Anderson Oct. 1967 20 p refs

(NWL-K-65/67; AD-664469) CFSTI: HC $3.00/MF $0.65

A detailed description is given for an IBM 7030 computer program designed to extrapolate HERO data. A flow chart of the program, a FORTRAN IV listing and samples of input and output formats are given. Author (TAB)

N68-18323# Harry Diamond Labs., Washington, D. C.

PROBLEM SOLVING BY DIGITAL–ANALOG SIMULATION

Howard M. Bloom Oct. 1967 74 p refs

(HDL-TR-1357; AD-664128)

An evaluation of four simulation languages, MIDAS, APACHE, MIMIC, and DSL/90, is made to determine their relative merits. The application of analog computer techniques to digital-analog simulation is considered. The problems discussed are as follows: Solution to a set of linear algebraic equations, linear programming, hybrid simulation, partial differential equations, boundary value problems, parameter optimization using a least squares error criterion and roots of polynomial equations. A mathematical outline of the technique or problem is given as well as the digital program, written in DSL/90, which is used to represent the problems. Possible improvements in the simulation language are shown. Some of the suggestions presented include the ability to dimension variables, and a means of using an interaction technique. TAB

N68-18339# Naval Weapons Lab., Dahlgren, Va.

A STRETCH COMPUTER PROGRAM FOR ORDERING HERO DATA TAPES

Larry E. Spangler Jan. 1968 29 p refs

(NWL-K-4/68; AD-664488)

The report contains a description of an IBM 7030 computer program used in HERO data analysis. Computer tapes of HERO tests may be ordered by ascending value of either the frequency field or the distance-orientation field of an identification record, depending on input option. The program can process data which contain both GO-NO-GO and regular entries. Author (TAB)

N68-18385# Institute for Scientific Information, Inc., Philadelphia, Pa.

DIAGONAL DISPLAY, A NEW TECHNIQUE FOR GRAPHIC REPRESENTATION OF COMPLEX TOPOLOGICAL NETWORKS

Eugene Garfield and Irving H. Sher 30 Sep. 1967 92 p refs

(Contract AF 49(638)-1547)

(AFOSR-68-0115; AD-664059) CFSTI: HC $3.00/MF $0.65

A new method has been developed for automatically drawing diagrams of topological networks containing a large number of interconnected nodes representing interrelated items, concepts, or events. The method allows a display of at least 100 nodes, permits an unlimited number of interconnections among nodes, is algorithmically manipulable, and is felt to be simple and aesthetically pleasing. Many known techniques for automatically drawing networks or graphs were reviewed, including those used in computer flow charting, electric circuit drawing, logical analysis, etc. A series of formats for displaying topological networks was tried, including a new format called Diagonal Display. This involves drawing nodes in a diagonal array and showing interconnections by rectangular lines in the adjacent areas. The upper or lower elbows of the lines for connecting edges fall into positions which correspond to the coordinates of a matrix representation of the network. To implement the automatic display by a computer-activated pen plotter, a program was written for a system employing an IBM 1401 computer and a Calcomp 563 plotter. The original impetus for this study was the need to display networks of bibliographic citations used in historical research or in searching scientific and technical literature. Other applications are also considered, including PERT diagrams, organizational charts, etc. TAB

N68-18386# Dalto Electronics Corp., Norwood, N. J.

SIMULTANEOUS 8 CHANNEL CATHODE RAY TUBE DISPLAY SYSTEM Final Report, Mar. 1964–Nov. 1966

James V. Gaudiosi Wright-Patterson AFB, Ohio AMRL Dec. 1967 75 p refs

(Contract AF 33(615)-2350)

(AMRL-TR-67-13; AD-664552) CFSTI: HC $3.00/MF $0.65

The report describes the technical features of an 8-channel Cathode Ray Tube Oscilloscope System. The primary features of this system are the following: (1) Individually, manual and remote voltage-controllable X and Y positioning is provided for each signal; (2) Individually, manual or remote voltage-controllable intensity is provided for each signal; (3) Overall manual X and Y positioning of the 8-signal group is provided; (4) X and Y positional stability within plus or minus 1% for a duration of 8 hours after a 15-minute warmup period is provided; (5) X, Y, and Z channels are dc-coupled throughout; (6) X and Y deflection amplifiers provide nominal 300 V peak-to-peak push-pull output swings symmetrical about ground; (7) X and Y deflection amplifier frequency response is flat from dc to 100 KC within plus or minus db at 85 volts peak-to-peak output and driving into a 500 pf load; (8) Remote (up to 20 feet) CRT driving capability is provided. The primary proposed utilization of the system is for providing the capability of synthesizing a variety of displays as related to cockpit instrumentation for conducting research in the area of simulation and training. Author (TAB)

N68-18469# Aerospace Corp., San Bernardino, Calif.

BALGOR: A PROGRAM FOR SOLVING LINEAR PROGRAMS IN ZERO ONE VARIABLES, JUNE–AUGUST 1967

Stephan J. Wersan Sep. 1967 310 p refs

(Contract F04695-67-C-0158)

(TR-0158(S3816-10)-1; SAMSO-TR-68-6; AD-664062)

The program solves for the X the linear program: Minimize C.DOT.X Subject to A*X.LE.Y where A is an array M x N (M.LE.256), Y is an array M x 1, C is an array N x 1 of given fixed-point numbers, and X is an array N x 1 of zeroes and ones.

The code achieves housekeeping economies by the use of an especially written threaded list processor THLP94 available separately.
TAB

N68-18472# Information Research Associates, Inc., Lexington, Mass.
A NONPARAMETRIC APPROACH TO PATTERN RECOGNITION. PART 1: THE LOCALLY DISJOINT CASE
Joel Owen, Donald B. Brick, and Ernest Henrichon 25 Nov. 1967 23 p refs
(Contract Nonr-4752(00))
(TR-15; AD-664218)

A mathematically rigorous procedure is developed which transforms the underlying unknown probability structure of a pattern discrimination problem to the real line. This transformed probability space is then partitioned using the fact that the locations of the relative extrema of the difference of empirical distribution functions will converge to the boundaries of the likelihood decision rule. In Part I, a method is proposed based on the locations of the relative extrema for discriminating between two disjoint pattern classes. It is shown that this procedure will produce perfect discrimination with probability 1. (When the classes are locally disjoint (defined in the text), perfect discrimination is possible with only a finite learning phase). In Part II this procedure is modified to include the non-disjoint case.
Author (TAB)

N68-18536*# North American Rockwell Corp., Anaheim, Calif.
STUDY OF SPACEBORNE MULTIPROCESSING, PHASE 2
Quarterly Report
L. J. Koczela 30 Oct. 1967 98 p refs
(Contract NAS12-108)
(NASA-CR-93431; C6-1476.16/33; QR-2) CFSTI: HC $3.00/MF $0.65 CSCL 09B

Activity during the Spaceborne Multiprocessor Study covered: detailed system analysis; organization logic design; failure detection, isolation, and reconfiguration; and software analysis. This report presents the results of the applied and natural parallelism investigations. Neighbor-to-neighbor communications were included in the organization and a discussion of this topic is contained in this report. The input/output scheme was investigated in depth and a preliminary description of the processor section prepared. The architecture of this organization is presented herein with a description of the general operation of the computer system. In addition, a description of the communication bus operation is included in this report.
Author

N68-18565# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
SOME CONSIDERATIONS ON THE STRUCTURE OF A SPECIALIZED DIGITAL COMPUTER FOR MACHINE TRANSLATION [NEKOTORYYE SOOBRAZHENIYA O STRUKTURE SPETSIALIZIROVANNOY TSIFROVOY MASHINY DLYA YAZ'KOVOGO PEREVODA]
I. S. Durgaryan and T. M. Ter-Mikaelyan 13 Jun. 1967 13 p Transl. into ENGLISH from Nauchn.-Tekhn. Inform. (SSSR), no. 2, 1967 p 44–46
(FTD-HT-66-583; AD-664537) CFSTI: HC $3.00/MF $0.65

A description is given of the structure of the separate units of a specialized electronic digital machine intended for accomplishing commercial machine translations. In particular, there is described the structure of the two-dimensional memory device, which enables one to have recourse both to the lines and the columns of the matrix of ferrite cores, such descriptions extending also to the arithmetical unit and the special operations carried out by it. The question of the structure of the commands is briefly discussed.
TAB

N68-18589# Joint Publications Research Service, Washington, D. C.
RATIONAL ENCODING OF AUTOMATA WITH THE HELP OF CANONICAL GRAPHS
S. P. Kartasheva *In its* Tech. Cybernetics 5 Mar. 1968 p 137–155 refs (See N68-18577 09-19)

An algorithm is proposed for encoding which realizes the minimum or close to minimum combination systems of single input automata. The essential differences of the given algorithm from other encoding methods (for example, the Hartmanis algorithm) are its simplicity and convenience for use with real automata. Here, the complexity of the structural diagram of the automata provided by the given algorithm is comparable to the complexity of the structural diagram of the automata given by the Hartmanis algorithm.
Author

N68-18590# Joint Publications Research Service, Washington, D. C.
METHOD FOR OBTAINING BINARY SYMBOLS WITH A GIVEN PROBABILITY OF THEIR OCCURRENCE
A. V. Kobchikov *In its* Tech. Cybernetics 5 Mar. 1968 p 156–163 refs (See N68-18577 09-19)

The method of obtaining the code "1" with a probability of p_{out} (1) using so-called logical conversion is investigated. Formulas are presented for probability conversion to the equations of the algebra of logic. Schemes for the practical realization of a controllable probability converter made of standard computer elements are given. The error in the given method is evaluated.
Author

N68-18620*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
ANALYTICAL INVESTIGATION OF SUPERSONIC TURBOMACHINERY BLADING. 1: COMPUTER PROGRAM FOR BLADING DESIGN
Louis J. Goldman and Vincent J. Scullin Washington Mar. 1968 66 p refs
(NASA-TN-D-4421) CFSTI: HC $3.00/MF $0.65 CSCL 10A

A FORTRAN IV computer program for the design of supersonic blading based on establishing vortex flow within the blade passage is presented. The method of characteristics, as applied to the two-dimensional isentropic flow of a perfect gas, was utilized for the blade design. The equations necessary for the design are developed. The information required for the program consists of an inlet flow angle, specification of the inlet, outlet, and lower- and upper-circular-surface Mach numbers, and the specific-heat ratio. The program output consists of the blade coordinates and, if desired, a printer plot of the blade profile and flow passage. In addition, supersonic starting and flow separation calculations are performed by the program and obtained as output. An example is included to indicate the use of the program and the results obtainable.
Author

N68-18724*# Ohio State Univ. Research Foundation, Columbus.
LEAST SQUARES ADJUSTMENT OF SATELLITE OBSERVATIONS FOR SIMULTANEOUS DIRECTIONS OR RANGES. PART 3: SUBROUTINES
Edward J. Krakiwsky, Jack Ferrier, and James P. Reilly Dec. 1967 54 p
(Contract NSR-36-008-033)
(NASA-CR-93424; Rept.-88) CFSTI: HC $3.00/MF $0.65 CSCL 09B

The purpose of the report is to present the documentation of the subroutines used in the "Least Squares Adjustment of Satellite Observations for Simultaneous Directions or Ranges" computer programs. Each write-up is self-contained, there are no references made to other subroutine write-ups. However, in many cases, the logic can be fully comprehended only by seeing the subroutine within the framework of the complete computer program.
Author

N68-18742*# Planning Research Corp., Los Angeles, Calif.
ONBOARD CHECKOUT AND DATA MANAGEMENT SYSTEM (OCDMS) COMPUTER SELECTION CRITERIA
D. H. Stomberg 25 Aug. 1967 36 p refs *Its* Tech. Advisement Memo. No. 171-5
(Contract NAS8-20367)
(NASA-CR-61613; PRC-D-1180) CFSTI: HC $3.00/MF $0.65 CSCL 09B

Software motivated performance/design criteria are developed to aid in the selection of Onboard Checkout and Data Management System (OCDMS) computers. The criteria are based on: compatibility with the OCDMS operating concepts, manufacturer-supplied software availability, and cost implications of supplementing that software. The mission baselines and multiple mission operational requirements for a family of OCDMS spaceborne computers are outlined. The organizational, central processor unit, and input/output features of various computer configurations are discussed in terms of software characteristics. A comparative analysis was carried out between the IBM 4π-EP and the Litton L-304 computers and it is shown that the L-304 has some basic advantages over the 4π-EP in terms of its overall organization. E.J.S.

N68-18753# Sandia Corp., Albuquerque, N. Mex.
AUTOMATIC THEOREM PROOFCHECKING IN SET THEORY
W. W. Bledsoe and E. J. Gilbert Jul. 1967 50 p refs
(Contract AT(29-1)-789)
(SC-RR-67-525) CFSTI: HC $3.00/MF $0.65

The research project on computer implementation of the Morse language, which was started at Sandia Corporation during the summer of 1966, has been continuing at Sandia Corporation and at the University of Texas in Austin. A preliminary report on the part of that activity which concerns the discovery of extended rules of inference valid in Morse's system and the writing of computer programs to check proofs using these rules is presented. Author (NSA)

N68-18775# Sperry Rand Corp., Philadelphia, Pa. Univac Div.
DEVELOPMENT OF A COMPUTER PROGRAM FOR GENERATING TROUBLE-SHOOTING DECISION TREES Final Technical Report, 1 Apr. 1966–31 Mar. 1967
T. J. Barry Hannom, Anthony J. Azzari, Alan I. Brooks, John R. Hunter, Leon Steinberg et al Wright-Patterson AFB, Ohio AMRL Sep. 1967 273 p refs
(Contract AF 33(615)-3666)
(AMRL-TR-67-83; AD-664603)

The general properties of troubleshooting decision trees are enumerated in detail, and the assessment of various, proposed algorithms for generating cost optimized trees is described. This assessment resulted in the selection of two algorithms (entropy and Cohn-Ott methods) for subsequent use in the set of programs developed. A Tree Building routine was designed so the user can select which algorithm is to be used on a given run or when to switch from the entropy to the Cohn-Ott method when their joint use is desired. Two additional programs (the Digital and Analogue Test Criterion Generators) were written to help the user determine the tolerance limits for a particular test. From the output of these routines, the user should be able to more easily construct the input to the Tree Building routine. Other input data required for running the Tree Building program include: (1) failure probabilities, and (2) time estimates of the testing subtests for each test. A demonstration test was completed and is described showing how the programs would be used. Input data were prepared using the Current Reference module of Tracking Antenna Electronic Amplifier (for the MG-13 fire control system of the F-101) as a representative equipment item. An explanation of the computer output is given, and the flow charts and listing for each of the programs developed in this study are documented. Author (TAB)

N68-18779# United Kingdom Atomic Energy Authority, Risley (England). Authority Health and Safety Branch.
DATA STORE REQUIREMENTS ARISING OUT OF RELIABILITY ANALYSES
A. R. Eames 1967 53 p refs
(AHSB(S)-R-138)

Information on the reliability of items of plant is required by the reliability analyst in carrying out safety assessments. This report outlines an example of how such reliability information might be collected, analysed and stored using computer techniques. Author

N68-18782*# Planning Research Corp., Los Angeles, Calif.
ONBOARD CHECKOUT AND DATA MANAGEMENT SYSTEM (OCDMS)
1 May 1967 85 p
(Contract NAS8-20367)
(NASA-CR-61612; PRC-R-852) CFSTI: HC $3.00/MF $0.65 CSCL 09B

The background of development of on-board checkout and data management systems is discussed in terms of its place in the general evolution of test and checkout operations. The on-board checkout and data management system is discussed in terms of the role of the system in the general mission, in terms of the system hardware requirements, and in terms of the system software requirements. The unresolved problems created by presently known mission requirements and the application of on-board checkout and data management systems to their solution is presented. Several deficient technology areas, in both technology and management techniques, are identified and related to advanced mission requirements. The report concludes with general conclusions and recommendations for continuing effort in this area. Author

N68-18783*# Planning Research Corp., Los Angeles, Calif.
SUPPORT SYSTEM FOR ONBOARD CHECKOUT AND DATA MANAGEMENT SYSTEM (OCDMS) SATURN/APOLLO APPLICATION PROGRAM
16 Jun. 1967 91 p
(Contract NAS8-20367)
(NASA-CR-61610; PRC-D-1177) CFSTI: HC $3.00/MF $0.65 CSCL 09B

This specification establishes the requirements for performance, design, test, and qualification of a computer program identified as the support system for the onboard checkout and data management system. The program provides the software tools and techniques to: 1) standardize computer programming and data management practices for a space-borne computer based system for the Saturn/Apollo Application (S/AA) program; 2) develop methods and procedures that give S/AA missions a traceability and correlation capability for all experimental data collected; 3) minimize test planning cost and simplification of configuration management tasks by means of the control and information processing capability of the onboard checkout and data management system software; and 4) generate S/AA experiment procedures and system software that provide maximum flexibility and expandability by such means as the programming and engineering language features for the computer based onboard checkout and data management system. Author

N68-18794# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ON QUESTION OF REALIZATION OF VARIATIONAL METHODS IN AVM (ANALOG COMPUTERS), AS APPLIED TO SOLUTION OF INTEGRAL EQUATIONS [K VOPROSU REALIZATSII VARIATSIONNYKH METODOV NA AVM PRIMENITEL'NO K RESHENIYU INTEGRAL'NYKH URAVNENIY]
A. F. Verlan' *In its* Cybernetics and Computer Technol. 31 Mar. 1967 p 1–5 refs (See N68-18793 09-10)

A method of approximating an integral equation by means of a system of algebraic equations is described. This constitutes a departure from the standard method of successive approximations used with analog computers, which is based on the Gauss–Seidel iterational process. The method is based on least squares and is illustrated by means of an analog solution of a Fredholm equation of the second kind. Author

N68-18796# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

CONTROL SYNTHESIS OF ARITHMETICAL UNIT OF A DIGITAL COMPUTER [SINTEZ UPRAVLENIYA ARIFMETICHESKOGO USTROYSTVA TSIFROUOY VYCHISLITEL'NOY MASHINY]

V. I. Kartashev *In its* Cybernetics and Computer Technol. 31 Mar. 1967 p 17–24 ref (See N68-18793 09-10)

Various types of control circuits based on the use of finite automata are described, and are broken up into three types. One covers control devices which have as many automata as there are microprograms in the control, with each automaton triggered by a signal from a central control unit. The second type uses one automaton in conjunction with a decoding block, which generates signals that change the state of the automaton in accordance with the required program. In the third type, the automaton is equipped with both a decoding unit and a circuit for the control of the micro-operations, in which case the automaton function reduces to timing of the operation steps. The synthesis of a control system for an arithmetic unit based on the latter modification is described. Author

N68-18801# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

AUTOMATION OF COMPLICATED PHYSICAL EXPERIMENTS AND INDUSTRIAL TESTS WITH HELP OF DIGITAL COMPUTERS [AVTOMATIZATSIYA SLOZHNYKH FIZICHESKIKH EKSPERIMENTOV I PROMYSHLENNYKH ISPYTANIY S POMOSCHCH'YU TSIFROVYKH VYCHISLITEL'NYKH MASHIN]

V. M. Yegipko *In its* Cybernetics and Computer Technol. 31 Mar. 1967 p 53–61 refs (See N68-18793 09-10)

The basic principles pertaining to the use of electronic computers as component parts of automatically-controlled complicated physical experiments or commercial tests are reviewed, and details are given on a universal control machine designed for automating various experiments. The system consists of a small, high-speed universal digital computer, equipped with a device which connects the machine to data units and servomechanisms of the object, and which permits visual control of the operation of the machine and of the individual elements of the automatic control system. The machine is designed for objects in which the number of pickups yielding information on the object does not exceed 250; the number of actuating mechanisms of two-position control does not exceed 30; and the volume of information used in realizing the control algorithm (including the algorithm itself) does not exceed 5000 26-digit binary numbers. Computer characteristics are described, and a theoretical example of an automatically-controlled experiment is given. Author

N68-18802# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

CERTAIN QUESTIONS OF EXPLOITATIONAL RELIABILITY OF DIGITAL CALCULATING AND CONTROLLING MACHINES [NEKOTORYYE VPOROSY EKSPLUATATSIONNOY NADEZHNOSTI TSIFROVYKH VYCHISLITEL'NYKH I UPRAVLYAYUSHCHIKH MASHIN]

L. A. Korytnaya *In its* Cybernetics and Computer Technol. 31 Mar. 1967 p 63–74 refs (See N68-18793 09-10)

Some problems involved in the operational reliability of digital computers and control machines are analyzed and the necessity for creating an effective system for automatic control of the correctness of machine operation as one of the means of incorporating operational reliability during the design stage is demonstrated. The analysis is based on a determination of the probability that the computer will go out of order within a certain time after its being turned on, and the probability of the correct operation of the individual computer elements. The failure probability of the digital computer is estimated by introducing the coefficients of effective utilization of the computer, the coefficient of effective maintenance and maintenance frequency, the operating expenditures, the maintenance expenditures, cost factors based on these expenditures, and other parameters. Author

N68-18804# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

SELECTION OF THE TYPE OF STANDARDS FOR CORRELATION READING AUTOMATA [VYBORTIPA ETALONOV DLYA KORRELYATSIONNYKH CHITAYUSHCHIKH AVTOMATOV]

V. K. Yeliseyev *In its* Cybernetics and Computer Technol. 31 Mar. 1967 p 83–89 refs Presented at the NTORiE Conf., Kiev, Jun. 1963 (See N68-18793 09-10)

Consideration is given to the selection of optimum (identification reliability) standards for reading automata, using the principle of optical correlation. The identification criterion is written in integral form. Any computing device for correlation functions operating with sign-alternating initial magnitudes can be used to find magnitudes of Q_k. Because the initial information is assigned in the form of flat figures, the simplest and most precise device is an analog correlator based on optical correlation of two images, a mask-standard and the image to be identified. The parameters of figures from different types of typewriters were measured, and it is concluded that only negative standards should be used for typewritten figures. Author

N68-18805# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

EQUIPMENT FOR THE TREATMENT OF OPTICAL INFORMATION USING GENERAL PURPOSE COMPUTERS [APPARATURA DLYA OBRABOTKI OPTICHESKOY INFORMATSII S POMOSHCH'YU UNIVERSAL'NYKH VYCHISLITEL'NYKH MASHIN]

V. I. Rybak *In its* Cybernetics and Computer Technol. 31 Mar. 1967 p 91–95 refs (See N68-18793 09-10)

Several computer methods of image scanning for pattern and character recognition are reviewed, and details are given on a set of devices which can introduce directly into the computer information on any given point of the figure. The coordinates are specified by the computer, and the picture serves as the memory core. In the devices described, the figure can be resolved into 256×256 spots. The photomultiplier current corresponding to each spot is amplified, transformed into a four-digit binary code, and transmitted to the arithmetic unit of the computer. By the end of the cycle, the computer receives this information on the reflection coefficient of a small section of the figure, selected beforehand by the program. The automatic control of photomultiplier sensitivity, and the errors connected with deviation of this control, are also discussed. Author

N68-18831*# Planning Research Corp., Los Angeles, Calif.

ONBOARD CHECKOUT AND DATA MANAGEMENT SYSTEM: DESIGN SUPPLEMENTARY

31 Mar. 1967 53 p refs *Its* Tech. Advisement Mem. No. 171-3 (Contract NAS8-20367)

(NASA-CR-61611; PRC-D-1403) CFSTI: HC $3.00/MF $0.65 CSCL 09B

Certain equipment design concepts of the Onboard Checkout and Data Management System (OCDMS) are extended and clarified. A functional logic design description is given of each of the major

OCDMS units that are controlled by the computer. These are the Computer Interface Unit (CIU), the signal adapters, and the Control and Display Unit (CDU). The detailed operation of the logic components is discussed with emphasis on the data transmission involved between units. Sample data and instruction formats are developed to facilitate system understanding. The data acquisition process is described from a programmer's viewpoint. Consideration is given to the inherent delays in operation due to OCDMS and experiment hardware reaction times that must be taken into account by the software. The extent to which self-test features are built into OCDMS and the recommended method of using them are mentioned. A data transmission system between the CIU and external devices, such as the signal adapters and CDU, is described. The system is estimated to be capable of roles in the vicinity of 500 kc over cables of virtually unlimited length by efficiently taking into account transmission line effects. R.N.A.

N68-18868# Los Alamos Scientific Lab., N. Mex.
MADMAC, A MADCAP VERSION OF DEC CODE MACRO-8 FOR ASSEMBLING PDP-8 CODES ON MANIAC
Allen C. Larson 28 Nov. 1967 30 p
(Contract W-7405-ENG-36)
(LA-3792) CFSTI: HC $3.00/MF $0.65

An assembler for PDP-8 codes written in a subset of the DEC-MACRO-8 language has been entirely written in the Maniac II compiler language MADCAP. This assembler will accept input from cards of paper tape. The paper tape can either be punched in the Maniac character code or in the ASCII character code. The major difference between MACRO-8 and MADMAC is that MADMAC does not have the macro pseudo-op. Author (NSA)

N68-18875# Iowa State Univ. of Science and Technology, Ames.
COMPUTER PROGRAM FOR INTERPRETATION OF SPARK SOURCE MASS SPECTROGRAPH PHOTOPLATES
R. J. Conzemius, D. H. Erbeck, and S. T. Elbert Oct. 1967 74 p refs
(Contract W-7405-ENG-82)
(IS-1693) CFSTI: HC $3.00/MF $0.65

A method is described that takes raw data from a spark-source mass spectrograph photoplate and utilizes computer techniques for both interpretation and computation of elemental impurity levels. A general description of the program is provided as well as a block diagram and complete listing. An example shows the type of input and output data. Limitations of the method are discussed briefly. Author (NSA)

N68-18883# United Kingdom Atomic Energy Authority, Harwell (England). Research Group.
ASSESSMENT OF DATA FROM AN AUTOMATIC NEUTRON DIFFRACTOMETER INSTALLATION
J. W. Hall and K. C. Turberfield Nov. 1967 12 p refs
(AERE-R-5642) HMSO: 1s 9d

The output from automatic neutron diffractometers present significant data handling, assessment, and presentation problems. At A.E.R.E. Harwell these diffractometers are to be served by PDP-8 installations that will automatically assess the measured data as to its reliability and significance, reduce it, and store it. The raw and reduced data can also be presented on demand on an oscilloscope/T.V. relaying system for visual assessment. In additon to the data handling facilities, programs will be available for crystallographic calculations needed for setting up crystal samples and for carrying out the measurements. Feed back facilities will enable erroneous or indadequate data to be remeasured either autonomously by program, or as initiated by the experimenter. Author

N68-18945*# Planning Research Corp., Los Angeles, Calif.
SUPERVISORY SYSTEM FOR ON-BOARD CHECKOUT AND DATA MANAGEMENT SYSTEM, (OCDMS), SATURN/APOLLO APPLICATION PROGRAM
16 Jun. 1967 91 p
(Contract NAS8-20367)
(NASA-CR-61614; PRC-D-1178) CFSTI: HC $3.00/MF $0.65 CSCL 09B

This specification establishes requirements for performance, design, test, and qualification of a computer program identified as a supervisory system for an On-board Checkout and Data Management System (OCDMS). The program is used to provide a spaceborne computer-based system with the functional capability to: (1) control system input and output; (2) manage data entities; (3) assess priorities and schedule system tasks; (4) respond to interrupt signals; (5) detect and recover from error or unusual conditions; (6) allocate computer storage; and (7) queue messages. As a basis of its operations, the program requires a pre-processed data base, application programs, and verified computer codes. Author

N68-18986*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
INTERPLANETARY INTEGRATING COMPUTER PROGRAMS
J. Reynolds Duncan, Jr. *In its* Astrodyn., Guidance and Control Rev. No. 1 21 Feb. 1968 p 11-18 (See N68-18983 09-30)

The numerically integrated programs which provide a trajectory that a spacecraft may follow to achieve a desired set of end conditions are discussed. The necessity of updating the factors contributing to program differences is considered, and the program components and the way in which these program parts fit together and work together to provide solutions to interplanetary trajectory problems are described. An overview of the makeup of these programs is given. The n-body problem described provides a method for the numerical integration of the equations of motion of the spacecraft and spherical homogeneous planets. The general perturbation theory and special perturbation theory are two approaches attempted for the solution to the n-body problem. The advantages and disadvantages of a few numerical integration techniques are presented. The expanded n-body solution is evaluated in relation to initial conditions and isolation routines. The problems confronting the isolation routine are given along with approaches to the solution of these problems. B.S.D.

N68-19092*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
VOYAGER SPACECRAFT PHASE B, TASK D. VOLUME 4: ENGINEERING TASKS. BOOK 3: CENTRAL COMPUTER Final Report
16 Oct. 1967 53 p refs
(Contract NAS8-22603)
(NASA-CR-93555; DIN-67SD4379, V. 4, Bk. 3) CFSTI: HC $3.00/MF $0.65 CSCL 09B

The relative merits of a centralized (central computer) approach versus a decentralized (separate subsystem) approach are assessed to (1) determine functional requirements against which the performance of competitive implementations may be measured; (2) synthesize separate subsystem and central computer systems for nine combinations of functional complexity and applied redundancy; and (3) perform a comparative evaluation in order to select the best system for handling the digital processing tasks in the Voyager spacecraft. Performance comparisons were made by numerical analysis implemented with comparable electronic techniques and degrees of redundancy to perform the same functions. The results indicate that the effect of economies in power, weight, and size for the central computer approach do not fully offset the inherent reliability of the separate subsystem approach. M.G.J.

N68-19234 Arizona Univ., Tucson.
THE SOLUTION OF OPTIMAL CONTROL PROBLEMS ON AN ITERATIVE HYBRID COMPUTER
Richard Lee Maybach (Ph.D. Thesis) 1967 172 p
Available from Univ. Microfilms: HC $8.00/MF $3.00 Order No. 67-6940

We formulate the problem by using Pontryagin's Maximum Principle. The required maximization of the Hamiltonian with respect to the u^j is accomplished by steepest ascent. The state equations, adjoint equations, Hamiltonian, and steepest ascent process are simulated on the analog portion of an iterative hybrid computer. This takes place at extremely high speed; a complete solution is generated in less than one millisecond. We solve this boundary-value problem by iteration. The analytical work is justified by hybrid computer solutions of undamped second- and third-order systems, a constrained second-order system, and Zermelo's navigation problem, all with a minimum-time criterion function, and a second-order system with nonlinear damping and a minimum time-plus-fuel criterion function. Typical solution accuracies are one to two per cent, and typical convergence times are on the order of a few seconds. Dissert. Abstr.

N68-19284# Iowa State Univ. of Science and Technology, Ames.
DIAN 2: AN ALL FORTRAN SYSTEM FOR PROGRAMMING A DIGITAL COMPUTER IN TERMS OF ANALOG COMPONENTS
H. L. Torrey, G. J. Farris, and L. E. Burkhart Aug. 1967 42 p refs
(Contract W-7405-ENG-82)
(IS-1656) CFSTI: HC $3.00/MF $0.65

DIAN-II is a completely revised version of an earlier DIAN programming system by which a digital computer may be programmed in a manner very similar to the technique of writing a flowsheet for an analog computer. In using DIAN-II, the programmer need be concerned only with the relations between inputs and outputs of basic computational components which perform specific mathematical operations. DIAN-II is written entirely in FORTRAN for IBM System 360 machines but can be very easily modified to run on any machine with a FORTRAN compiler. The basic system consists of seven types of components—integrators, summers, constant multipliers, function multipliers, dividers, sine generators, and empirical function generators. Author (NSA)

N68-19299* Boeing Co., Seattle, Wash. Space Div.
A GUIDE TO THE AUTOMATED ENGINEERING AND SCIENTIFIC OPTIMIZATION PROGRAM AESOP
D. S. Hague and C. R. Glatt [1967] 178 p refs
(Contract NAS2-4507)
(NASA-CR-73201) CSCL 09B

The AESOP is described as a flexible, large scale digital computer program designed for solving a wide range of multivariable parameter optimization problems on an IBM 7094 computer. The nine available search techniques are cited as sectioning, adaptive creeping, steepest-descent, quadratic search, Davidon's method, random point search, random ray search, pattern, and magnification. Program usage is outlined, the coupling of the mathematical model to the optimizer is described, and data input for optimization and printing and plotting data is discussed. The 57 subroutines are described. M.G.J.

N68-19313 Arizona Univ., Phoenix.
HIGH-SPEED MONTE CARLO TECHNIQUE FOR HYBRID-COMPUTER SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS
Howard Handler (Ph.D. Thesis) 1967 189 p
Available from Univ. Microfilms: HC $8.60/MF $3.00 Order No. 67-6932

The analog-hybrid computer Monte Carlo technique for solving elliptic and parabolic partial differential equations has been implemented on a new hybrid computer capable of taking statistics over 1,000 two- or three-dimensional random walks each second. This exceptional computing speed and flexible digital control permit direct plotting of partial differential equation solutions; of perhaps even greater interest is the incorporation of such Monte Carlo routines in real-time analog computer setups in process control applications. In this connection, the Monte Carlo method has been extended to a wider class of boundary conditions especially applicable to heat conduction/diffusion problems. Dissert. Abstr.

N68-19336*# National Aeronautics and Space Administration, Electronics Research Center, Cambridge, Mass.
SOME ARGUMENTS FAVORING NON-CONVENTIONAL TYPES OF COMPUTERS
Wayne A. Lea Washington Mar. 1968 35 p refs
(NASA-TM-X-1544) CFSTI: HC $3.00/MF $0.65 CSCL 09B

This paper considers the basic question of the adequacy of conventional, general-purpose digital computers, and whether new, non-conventional machine structures would be useful for expanding the capabilities of machine performance, to permit automatic solution of problems previously handled only by humans. Included in the class of "non-conventional" machines discussed herein are hybrid machines, multiprocessors, highly parallel computers, Holland and SOLOMON machines, bionics models, diffused-function anastomotic networks, pattern recognition machines, "linguistically intelligent" machines, and other more exotic machines. Several arguments favoring non-conventional machine structures are presented. Considered separately are arguments based on: (a) the opinions of certain experts; (b) ultimate theoretical capabilities of various machine types; (c) structures of biological counterparts in brains and nervous systems; (d) the potential for natural-language programming; (e) relative computational economies and efficiencies; and (f) the potential for successful development of new types of computer structures. Such arguments demonstrate the problems one can get into by confining study to present-day digital computer organizations, and the potential advantages of new, user-oriented designs. Author

N68-19485# Stanford Univ., Calif. Dept. of Computer Science.
MACHINE UTILIZATION OF THE NATURAL LANGUAGE WORD 'GOOD'
Kenneth Mark Colby and Horace Enea 25 Sep. 1967 11 p refs
(Grant PHS-G-MH-06645-07)
(CS-78; PB-176771) CFSTI: HC $3.00/MF $0.65

Using the term 'good' as an example, the effect of natural language input on an interviewing computer program is described. The program utilizes syntactic and semantic information to generate relevant plausible inferences from which statements for a goal-directed man-machine dialogue can be constructed. Author

09 ELECTRONIC EQUIPMENT

Includes electronic test equipment and maintainability; component parts, e.g., electron tubes, tunnel diodes, transistors; integrated circuitry; microminiaturization. For basic research see: 10 Electronics. For related information see also: 07 Communications and 21 Navigation.

N68-18274# Rome Air Development Center, Griffiss AFB, N. Y.
THE SCR AS A HIGH POWER MODULATOR SWITCH
Anthony S. Cardello Dec. 1967 72 p refs
(RADC-TR-67-625; AD-664331)

The report is a survey of the current state of the art in the use of silicon controlled rectifiers in high power modulator

switch series. A brief description of the device and device characteristics is included. The report describes several contractual efforts which proved the feasibility of applying the devices to high power equipments and in detail describes the device, development of circuitry, triggering techniques and device improvements. The applications discussed in the report show that the silicon controlled rectifier has been used in a 5 megawatt modulator and is capable of operation at power levels of 25 megawatts and beyond. Continued efforts in this area will prove the high power capability of the device in practical applications. Author (TAB)

N68-18299# Applied Science Associates, Inc., Valencia, Pa.
DEVELOPMENT OF FULLY PROCEDURALIZED TROUBLESHOOTING ROUTINES Final Report, Apr.–Nov. 1966
Thomas K. Elliott Wright-Patterson AFB, Ohio AMRL Nov. 1967 64 p refs
(Contract AF 33(615)-3966)
(AMRL-TR-67-152; AD-664076)

Several studies over the past decade have shown that proceduralized troubleshooting can produce acceptable or better performance of this complex maintenance task while permitting substantial reduction in the costly training typically associated with its accomplishment. The term proceduralized troubleshooting is usually applied when the decision about where the system the technician is to check next, based on the results of previous checks, is made by a performance aid which directs his actions. This same performance aid, however, can also display expected normal readings and tolerance, test point locations, test equipment and test selection parts identification, and much other necessary and/or useful guidance. The method described follows from experiences with and subsequent to development of a fully proceduralized within stage troubleshooting performance system for purposes of experimental evaluation. It is based upon the rationale of maximizing information gain per unit test or operation cost. Examples of troubleshooting procedures developed for use in the evaluation are presented and described. Author (TAB)

N68-18300# Applied Science Associates, Inc., Valencia, Pa.
THE MAINTENANCE TASK SIMULATOR (MTS-2): A DEVICE FOR ELECTRONIC MAINTENANCE RESEARCH. VOLUME 2: MAINTENANCE DATA Final Report, Apr. 1966–Apr. 1967
Thomas K. Elliott Wright-Patterson AFB, Ohio AMRL Oct. 1967 204 p refs
(Contract AF 33(615)-3966)
(AMRL-TR-67-140, V. 2; AD-664077)

The report contains schematics, theory of operations, parts location, and interconnection tables for the MTS-2 maintenance task simulator. The data includes front panel modules and circuit modules, but excludes commercial items incorporated intact in the device. Author (TAB)

N68-18317# Radio Corp. of America, New York. Advanced Communications Technology Lab.
MICROMINIATURE MONOLITHIC CROSSPOINT INTERCONNECTIONS Final Report, 1 Jul. 1966–30 Sep. 1967
S. Yuan, W. H. Buchsbaum, M. Kalet, and L. Spann Dec. 1967 152 p ref
(Contract DA-28-043-AMC-02260(E))
(CR-67-565-35; ECOM-02260-F; AD-664126)

The report describes the techniques used for fabricating a 1 x 4 microminiature crosspoint. It also presents results from electrical tests made on 1 x 1 and 1 x 4 crosspoints. A general discussion of process steps for manufacturing beam-lead diodes is given, followed by descriptions of the deposition and etching of chromium resistors and the gold interconnection patterns, mounting of monolithic logic chips, ultrasonic wire bonding, mounting of beam-lead diodes and the final packaging of a 1 x 4 crosspoint. Author (TAB)

N68-18333# Army Electronics Labs., Fort Monmouth, N. J.
TEMPERATURE PERFORMANCE MEASUREMENT METHODS FOR TEMPERATURE-COMPENSATED QUARTZ OSCILLATORS
Stanley S. Schodowski Oct. 1967 32 p refs
(ECOM-2896; AD-664157)

Extensive temperature performance measurements associated with temperature-compensated quartz oscillators (TCXOs) have led to the need for automatic test methods. Manually operated and attended measurements, when applied to the TCXO, become grossly inefficient. Also, the high degree of nonlinearity of the TCXO frequency-temperature characteristic and long and unequal/thermal time constants of TCXO components place greater demands on accurate frequency-temperature (F-T) stability determination than are normal for wide temperature range, non-oven controlled quartz oscillators. This report considers the steady-state and transient temperature behavior of TCXOs in a test environment and its relationship to temperature performance measurement errors. A common occurring nonlinearity and end point temperature slope of the F-T characteristic establish a maximum measurement temperature interval and minimum end point measurement temperature accuracy. Mathematical approximations of the thermal response of frequency determining TCXO components to step air temperature changes permit relating measurement error to the time of measurement. Then, maximum frequency-temperature coefficients and transient temperature differences between crystal and compensation network thermistors can be employed to estimate stabilization time under worst case conditions. Two methods applicable to an automatic measurement system, the sequential and continuous scan methods, are described and measurement error curves are plotted which permit the selection of either sequencing or scan rate for a specific TCXO design. Author (TAB)

N68-18345# Army Electronics Labs., Fort Monmouth, N. J.
INFLUENCE OF ELECTRODE MATERIAL ON HIGH-VOLTAGE VACUUM BREAKDOWN
M. H. Zinn, G. W. Taylor, and M. M. Chrepta Jan. 1968 20 p refs
(ARPA Order 517)
(ECOM-2901; AD-664145)

The question of which electrode in a two-electrode system, the anode or the cathode, contributes most to the primary voltage breakdown mechanism, and the reasons for this contribution have been the subject of wide debate among workers in the field. Theories of breakdown that involve the anode or the cathode or both to varying extent have been proposed by Cranberg, Alpert, et al, Slivkov, Utsumi and Dalman, and others. Recent data collected by Watson, Mulcahy, and Bell and by Kranjec and Ruby, when subjected to analysis, indicate a role of the anode material in the breakdown process sufficiently clear to be applied in high-voltage vacuum tube construction. Both the analysis and data collected by Taylor and Chrepta indicate that heating of the anode owing to the flow of field emission is a primary cause of breakdown at spacings of interest in vacuum tube technology. Author (TAB)

N68-18348# Army Electronics Labs., Fort Monmouth, N. J.
ENERGY CONTROL FOR MICROWAVE AMPLIFIER ARRAYS
George W. Taylor and Sol Schneider Nov. 1967 17 p refs
(ECOM-2897; AD-664150)

In large systems using microwave amplifier arrays, the size, weight, and cost of individual energy sources require consideration of the use of a common power supply and energy storage bank. Complex energy control techniques may be necessary to protect the rf amplifier and to provide isolation of the faulted amplifier from the common energy source to prevent voltage variations on

the remainder of the system. Two approaches using available components may be used. The first uses multiple energy diverters, one to protect the rf tube, the other to blow a fuse if isolation from the common energy source is required. The on-time of this system is dependent on: (1) the reliability of the microwave amplifier; (2) the ability of the plasma-injection vacuum energy diverter to extinguish reliably and thereby limit the number of fuse replacements; and (3) the reliability of the fuse to blow almost instantaneously from a high surge current and prevent large voltage changes on the other amplifier tubes. The second approach uses a vacuum tube isolator, which eliminates the latter two of these requirements. In this case the energy diverter does not need to be extinguished by special circuit design. The vacuum tube isolates the circuit each time the energy diverter is fired. Additional circuit complexity and higher power supply voltages are required because of the relatively high tube drop of presently available power tubes. However, the power requirement for the system can be decreased, voltage regulation can be improved, and large decreases in the size of the secondary capacitance bank can be obtained. Author (TAB)

N68-18359# Army Electronics Labs., Fort Monmouth, N. J.
HIGH POWER INCOHERENT LIGHT SOURCES
Aris Papayo and Rudolf G. Buser Nov. 1967 19 p refs
(ECOM-2899; AD-664148) CFSTI: HC $3.00/MF $0.65

A survey of various aspects of high-power incoherent light sources, namely electrical and optical parameters and certain problems of optical pumping, is given. Standard flashlamps as well as the more recent high power ultraviolet pump lamps are discussed. The relevant numbers given allow comparison of these light sources for given optical pumping requirements. High pressure arc discharge sources are not discussed. Author (TAB)

N68-18395# Applied Science Associates, Inc., Valencia, Pa.
THE MAINTENANCE TASK SIMULATOR (MTS-2): A DEVICE FOR ELECTRONIC MAINTENANCE RESEARCH. VOLUME 1: APPLICATION AND OPERATION Final Report, Apr. 1966–Apr. 1967
Thomas K. Elliott Wright-Patterson AFB, Ohio AMRL Oct. 1967 41 p refs
(Contract AF 33(615)-3966)
(AMRL-TR-67-140, V. 1; AD-664085)

The MTS-2 was developed in response to a demand for a realistically complex, relatively low cost, reliable, substrate on which the tasks associated with electronic maintenance could be performed. It provides the capability for collection of performance data on such tasks as front panel check-out, between and within stage trouble-shooting, alignment, and remove-replace operations, with a minimum of interference with task performance. A time based record of control manipulations, component exchanges, and test point tests is automatically printed. In addition, the device provides a measure of capability for varying such equipment characteristics as front panel layout, type of controls and displays, type of internal circuitry, data flow configuration, etc. Physically, the MTS-2 is composed of six relay racks which contain or support 96 solid-state circuit modules of 20 types, 85 controls and displays of 15 types, and all response sensing and recording equipment. Author (TAB)

N68-18430# General Electric Co., Owensboro, Ky. Tube Dept.
C-BAND AND X-BAND DUAL FUNCTION OSCILLATORS Quarterly Report, 1 Jun.–31 Aug. 1967
J. D. Marshall and J. B. Quirk Dec. 1967 12 p
(Contract DA-28-043-AMC-02340(E))
(RCS-OSD-1366; ECOM-02340-5; QR-5; AD-664125)

A sufficient number of tubes of the two-layer etched frame grid design were made for life testing and retubing. One lot of tubes having the interlaced damper wire grid structure has been made. Increased Gm and attendant alteration of feedback phase necessitated reoptimizing the C-band oscillator. Reoptimization resulted in the deletion of the phasing line within the grid sleeve of the oscillator. The modified oscillator is called Oscillator DC-57. The C-Band oscillators for life tests and final evaluation were assembled and initial data recorded. The performance from unit to unit is remarkably uniform. Tests were initiated to determine the reason for the unexpectedly poor performance of the laminated etched grid frame design tubes at X-Band frequencies. Computer results confirm the experimental results. Results of computer analysis do indicate, however, that if the interelectrode spacings were changed, and then if the appropriate voltages were applied in a circuit with the proper feedback phase and magnitude, that a peak power of 63 watts to 76 watts could be expected. Author (TAB)

N68-18502*# TRW Systems Redondo Beach, Calif.
STUDY: HIGH DIELECTRIC CONSTANT THIN FILM CAPACITOR MATERIALS. DELIVERABLE HARDWARE PROCESS SPECIFICATIONS AND TEST DATA Materials Report
R. P. Radke 26 Apr. 1967 33 p ref
(Contract NAS9-5592)
(NASA-CR-65986) CFSTI: HC $3.00/MF $0.65 CSCL 09A

This document describes the items of deliverable hardware required in the study of high dielectric constant thin film capacitor materials. The hardware consists of numerous substrates containing sodium niobate capacitors and substrates containing the sodium niobate dielectric material only. The materials and processes used in fabricating the hardware are delineated. Various tests performed on the hardware, such as temperature coefficient of capacitance, frequency response, D. C. leakage, voltage breakdown, and stability are described and the test results shown. In additon, the capacity and dissipation factor of all substrates are indicated along with the dielectric thickness and the calculated dielectric constant. Author

N68-18518* Gulton Industries, Inc., Hawthorne, Calif. Engineered Magnetics Div.
EMSE123 PHASE SENSITIVE DEMODULATOR Final Report
J. A. Cox 18 Apr. 1966 25 p
(Contract NAS9-2524)
(NASA-CR-65984; EM-1908) CSCL 09E

Electrical and mechanical design data and performance specifications for the EMSE123 phase sensitive demodulator which is to provide 5 VDC for in-phase and 0.00 VDC for out-of-phase ac signals are reported. S.C.W.

N68-18545# Ion Physics Corp., Burlington, Mass.
HIGH VOLTAGE BREAKDOWN STUDY Quarterly Progress Report, 16 May–15 Aug. 1967
W. R. Bell, M. J. Mulcahy, and A. Watson Dec. 1967 94 p refs
(Contract DA-28-043-AMC-00394(E); ARPA Order-517)
(ECOM-00394-11; QPR-11; AD-664123)

The block of eight experiments was completed during the reporting period. This consisted of the study of unconditioned and conditioned gaps in the range 0.25 to 3.0 cm and a parallel experiment to study the effect of the presence of magnetic field. Both physical and statistical analyses of the results were carried out and yielded very interesting trends which are consistent with the theories developed. The 300 kv apparatus was completely overhauled and cleaned. The chamber and flanges were electro-polished, the electrode system redesigned and the bakeable bushing replaced. The Universal Voltronics and Van de Graaff power supplies were also overhauled and new baking and pumping systems designed, installed and commissioned. The new baking system provides for a consistent automated baking cycle for all future treatments. The design of the trigger unit for the energy storage crowbar was completed. Finally, the preliminary design and selection of factors for the next experiment was initiated. Author (TAB)

N68-18559* Gulton Industries, Inc., Hawthorne, Calif. Engineered Magnetics Div.

EM2000D4 dc AMPLIFIER Final Report

J. A. Cox 14 Apr. 1966 82 p

(Contract NAS9-2524)

(NASA-CR-65983; EM-1905) CSCL 09A

Electrical and mechanical design are discussed for a dc amplifier to provide excitation to and amplify signals from strain gauge bridges, pressure transducers, temperature sensors, and similar devices. Four generations of dc amplifiers and their evolutionary progress toward smaller size and increased efficiency are described; and the final model uses a more dense packaging concept and improved circuitry. Its volume is 6.5 cu in., weight is 6-1/2 lb, and drain is 98 mA. The main circuit of the dc amplifier is the low level chopper which converts the dc signal input to a proportional ac; and, therefore, the unavoidable direct coupled amplifier does not contribute to the error of the composite amplifier. Internal wiring is primarily resistance welded, with certain interconnections of stranded copper wire; and solid encapsulation of the finished unit insures maintenance of desired subassembly configuration under severe environmental conditions. M.W.R.

N68-18598 Australian National Univ., Canberra. Dept. of Engineering Physics.

A SURVEY OF ISOLATION AMPLIFIER CIRCUITS

I. D. G. MacLeod Feb. 1967 42 p refs

(EP-RR-13) Available from the Australian Natl. Univ. Press, P.O. Box 4, Canberra, A.C.T., 2600, Australia: HC$A1.00

The rejection of relatively large common-mode voltages and the simultaneous amplification of small signal voltages is a common requirement in instrumentation and control. Conventional differential amplifiers are usually satisfactory, but in applications involving large or rapidly changing common-mode voltages, more effective isolation of the signal voltage is required. Methods of coupling a signal voltage between two differing common-mode potentials are examined, and an assessment is made of each method's suitability for particular applications. Author

N68-18617* Gulton Industries, Inc., Hawthorne, Calif. Engineered Magnetics Div.

EMSE125 FREQUENCY TO VOLTAGE CONVERTER Final Report

J. A. Cox 27 Apr. 1966 33 p refs

(Contract NAS9-2524)

(NASA-CR-65985; EM-1911) CSCL 09A

This report discusses the development phase of the electrical and mechanical design of the frequency to voltage converter. The converter is designed to measure accurately the frequency of the input ac signal and convert it to a 0 to 5 V dc output. Covered in the report are performance specifications, design, and solutions to production problems that were encountered. An acceptance test procedure was written and used to test the preproduction and production units. An electromagnetic interference test procedure was also written. K.W.

N68-18866# Los Alamos Scientific Lab., N. Mex.

FABRICATION OF A COAXIAL SHOCK-SENSITIVE SWITCH

R. S. Kirby 16 Nov. 1967 7 p

(Contract W-7405-ENG-36)

(LA-3759) CFSTI: HC$3.00/MF$0.65

A technique was developed for fabricating a coaxial switch using metal inner and outer conductors separated by a CdS insulation which becomes an electrical conductor on exposure to an explosive shock wave. Coaxial assemblies of 0.040 and 0.025 in. o.d. were fabricated using a copper outer conductor and an 1100 Al inner conductor. Author (NSA)

N68-19057# Royal Aircraft Establishment, Farnborough (England).

AN EASILY CONSTRUCTED HIGH-PRESSURE LAMP FOR INTENSE LIGHT PULSES IN THE NANOSECOND RANGE [LEICHT ZU BAUENDE HOCHDRUCKLAMPE ZUR ERZEUGUNG VON INTENSIVEN LICHTIMPULSEN IM NANOSEKUNDENBEREICH]

H. G. Franke and H. Schmeing Nov. 1967 9 p refs Transl. into ENGLISH from Nucl. Instr. and Methods (Denmark), v. 52, no. 1, 1967 p 171–172

(RAE-LIB-TRANS-1266) CFSTI: HC$3.00/MF$0.65

A lamp of the gaseous-discharge type is described, which generates subnanosecond light pulses. It is filled with hydrogen to 30 atms pressure. The lamp can easily be built within a few hours. Author

N68-19062*# National Aeronautics and Space Administration. Electronics Research Center, Cambridge, Mass.

CHARACTERISTICS OF TUNNELING P-N JUNCTIONS

John B. Hopkins Washington Mar. 1968 22 p refs

(NASA-TN-D-4403) CFSTI: HC$3.00/MF$0.65 CSCL 09A

Procedures have been developed for the calculation of current-voltage characteristics of tunneling p-n junctions in semiconductors, given material constants and impurity-doping parameters. Accuracy higher than that acquired in similar efforts has been attained. When a digital computer is used, numerical differentiation permits calculation of parameters relevant to microwave mixing and detecting applications for tunnel and backward diodes in any elemental or compound semiconductor. Typical results are indicated. Author

N68-19185*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AN AUTOMATIC BALANCING SYSTEM FOR USE ON FRICTIONLESSLY SUPPORTED ATTITUDE-CONTROLLED TEST PLATFORMS

Norman M. Hatcher and Richard N. Young Washington Mar. 1968 24 p ref

(NASA-TN-D-4426) CFSTI: HC$3.00/MF$0.65 CSCL 14B

An automatic balancing system for frictionlessly supported, attitude-controlled test platforms about axes that are commonly orthogonal to the gravity vector is discussed. The system determines imbalance during limit-cycle operation by measuring the difference in total impulse exerted by opposing torquers that are used for attitude control in each axis to be balanced during some time interval. The system then moves a small weight by an appropriate distance to compensate for the measured imbalance. A model of the automatic balancing system has been constructed and tested on an air-bearing-supported platform that was fitted with sun sensors and a reaction-jet attitude-control system. Results indicated that the automatic balancing system can consistently balance this platform more accurately than it can be balanced manually, and that it can maintain this balance throughout prolonged test periods. The average accuracy to which the system balanced the platform during the tests was approximately 3000 dyne-cm. The system is compatible with present-day attitude-control systems, requires little power, and can be made small in weight and volume. Author

N68-19209*# General Electric Co., Syracuse, N. Y. Electronics Lab.

SOLID STATE IMAGE SENSOR RESEARCH, PHASE 2

W. E. Davern, D. P. Dwyer, G. C. Gerhard, R. E. Glusick, L. S. Jobin et al Mar. 1968 68 p refs

(Contract NAS12-131)

(NASA-CR-86039) CFSTI: HC$3.00/MF$0.65 CSCL 09A

The development of a solid state image sensor array is described. The array consists of 50 InAs photodiodes fabricated in a monolithic structure. Each diode is connected, by thin-film leads, to external preamplifiers. The thin-film lead structure is part of a molded plastic substrate that permits the use of batch-fabricated

leads, and provides the vacuum enclosure for frost-free operation at −80°C. Preamplifier circuits match the photovoltaic signal of the photodiodes to charge-storage capacitors, in order to provide frame time integration of the optical signal. The entire structure has been packaged for test and demonstration. Author

N68-19290 North Carolina State Coll., Raleigh.
A STUDY ON THE EFFECTS OF Co^{60} γ-RADIATION ON STEAM-GROWN SiO_2 MOS STRUCTURES
Robert Joseph Mattauch (Ph.D. Thesis) 1967 185 p
Available from Univ. Microfilms: HC $8.40/MF $3.00 Order No. 67-7426

Metal Oxide Semiconductor (MOS) capacitors were fabricated on both p- and n-type silicon substrates which had been thermally oxidized in a steam atmosphere. Capacitance-bias voltage curves were obtained with a measuring frequency of 100 kHz for both type devices. Device curve shift along the bias voltage axis yielded data from which it was deduced that the oxide charge moved by a diffusion mechanism. That charge was found to be positive and have an activation energy very near that of sodium in fused silica. A surface state density determination technique was employed and it was learned that the exposure of 3.6×10^6 roentgens caused the density of charges located at the oxide-semiconductor interface to increase from 10^{11} cm^{-2} eV^{-1} by an order of magnitude. A model based upon the Compton effect in the oxide is presented to explain the noted oxide charge change. Dissert. Abstr.

N68-19363*# Raytheon Co., Waltham, Mass. Microwave and Power Tube Div.
THERMIONIC CATHODE EVALUATION STUDY Interim Report, 1 Oct.–31 Dec. 1967
F. H. Hill 29 Jan. 1968 35 p Prepared for JPL
(Contracts NAS7-100; JPL-951810)
(NASA-CR-93672; PT-1735; IR-3) CFSTI: HC $3.00/MF $0.65 CSCL 09A

Diodes using pore-dispenser cathodes have completed 2500 hours of life burning and are operating satisfactorily at cathode temperatures of 950°C to 1100°C and at cathode currents from 0.2 A/cm^2 to 1.6 A/cm^2. Eight diodes using oxide-coated cathodes have completed 1240 hours of life burning and have shown a slump in emission of 5% to 25% at cathode temperatures of 825°C and 850°C and at cathode current levels from 0.225 A/cm^2 to 0.60 A/cm^2. Eight diodes using oxide cathodes with anode-to-cathode spacing of 0.025 in. have been built, exhausted and pretested for life burning operation of the T1 and T2 life-test conditions of 0.075 A/cm^2 to 0.300 A/cm^2. The coated-particle cathodes show the capability of being operated up to 0.55 A/cm^2 at 900°C. Further tests with higher current levels above 0.55 A/cm^2 show unexpected inhibited emission. Further study has shown the coated-particle cathode capable of pulsed operation up to 1.5 A/cm^2 peak current with a 3% duty cycle. Author

N68-19395*# Texas Instruments, Inc., Dallas.
PHOTON-COUPLED ISOLATION SWITCH Quarterly Report, 1 Jul.–30 Sep. 1967
E. L. Bonin and E. E. Harp 30 Sep. 1967 20 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951340)
(NASA-CR-93668; TI-03-68-14; QR-7) CFSTI: HC $3.00/MF $0.65 CSCL 09A

The photon-coupled isolation switch is a new type of semiconductor device which uses internal optical coupling to obtain electrical isolation between the driving source and the output terminals. Internal photon generation and detection techniques are used which combine a gallium arsenide (GaAs) photon-emitting diode with a silicon (Si) phototransistor. A third semiconductor wafer in the isolation switch is a monolithic Si driver circuit for supplying bias to the GaAs diode. The driver circuit uses DTL circuitry to provide for up to ten inputs. Author

N68-19433*# General Electric Co., Schenectady, N. Y. Tube Dept.
DEVELOPMENT OF HIGH-TEMPERATURE, HIGH-CURRENT, ALKALI-METAL, VAPOR-FILLED, CERAMIC THYRATRONS AND RECTIFIERS Quarterly Progress Report
A. W. Coolidge 6 Oct. 1965 27 p
(Contract NAS3-6005)
(NASA-CR-54751; GES-23-467; QPR-5) CFSTI: HC $3.00/MF $0.65 CSCL 09A

A thallium-filled diode was evaluated with respect to cathode emission, effect of vapor pressure, and inverse emission vs anode temperature. The tube was operated for 500 hrs at an average current of 2 amperes. The contract was redirected such that remaining effort will be concentrated on cesium filled tubes. Fabrication of two 15-ampere cesium-filled thyratrons was started. Author

10 ELECTRONICS

Includes circuit theory; and feedback and control theory. For applications see: 09 Electronic Equipment. For related information see: Specific Physics Categories.

N68-18301# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
MULTI-DIMENSIONAL AUTOMATIC SYSTEMS
P. I. Chinayev 7 Sep. 1967 242 p refs Transl. into ENGLISH of the book "Mnogomernyye Avtomaticheskiye Sistemy" Kiev, Gos. Izd. Tekhn. Lit. USSR, 1963 p 1–279
(FTD-MT-66-03; AD-664548)

Certain questions are considered on the theory of linear multidimensional automatic systems. On the basis of the effective method of comparing matrix equations of multidimensional systems considered as a consecutive connection of networks, methods of analysis and synthesis of multidimensional automatic systems have been developed. Separate chapters of the book are dedicated to new questions on the theory of invariance and multidimensional self-adjusting systems. The book is intended for scientists and engineers studying synthesis and analysis of systems with many adjustable magnitudes, and also can be useful for students of technical higher educational institutions during the study of a course of automatic control and adjustment. TAB

N68-18350*# Arizona Univ., Tucson.
INTENTIONAL NONLINEARITY IN A STATE VARIABLE FEEDBACK SYSTEM
Hasmukhrai Bhawanidas Parekh (M.S. Thesis) 25 Aug. 1967 91 p refs
(Grant NGR-03-002-115)
(NASA-CR-93412) CFSTI: HC $3.00/MF $0.65 CSCL 09C

In this thesis a particular type of nonlinear state variable feedback system is discussed. The system contains a single nonlinearity, and it is shown by describing function techniques and examples, that the optimum location of the nonlinear element for maximum control is at the left end. A method for designing gain-insensitive systems is presented, and it is shown by simple reasoning and examples that the system response for the gain-insensitive design is better than that of systems designed by conventional state variable feedback. A method is given to overcome the effects of saturation within the fixed plant by introducing an intentional nonlinearity to limit the saturating elements to their linear regions of operation. This makes it possible to apply the above gain-insensitive design technique so that the nonlinear plant can be made absolutely stable for all gain. The proposed method is then applied to improve the response of a fuel valve servomechanism, and the system is evaluated using an analog computer. Author

N68-18353# Yale Univ., New Haven, Conn. Dept. of Statistics.
ROBUST REGRESSION BY MODIFIED LEAST-SQUARES
Daniel A. Relles Dec. 1967 135 p refs
(Contract Nonr-609(52))
(TR-3; AD-664508)

Estimates of regression parameters are usually found by minimizing the sum of squared differences between observed and predicted values of a dependent variable. As is well known, such estimates can be seriously impaired by the presence of outliers. To combat this effect, I consider minimizing an alternative function of differences. This function is the square for arguments less than a certain value (determined from the data itself) and linear for arguments beyond that. An algorithm for computing the estimate is given, large-sample properties are derived, and small-sample properties are studied by means of Monte Carlo exploration of various error distributions. An extended summary of results is given.
Author (TAB)

N68-18358# Army Electronics Labs., Fort Monmouth, N. J.
WAVE PROPAGATION ON SINGLE CARRIER BEAMS OF CYLINDRICAL GEOMETRY IN A FINITE MAGNETIC FIELD
Bruno Zotter Oct. 1967 23 p refs
(ECOM-2891; AD-664149) CFSTI: HC $3.00/MF $0.65

Wave propagation in a collisionless beam of single-charge carriers, such as an electron beam, is analyzed in terms of modes of axial symmetry. It is found that four modes are usually sufficient to fulfill the initial conditions, but under certain conditions six modes can exist. The mode amplitudes are calculated and a magnetic field dependence is found for an additional term in the space-charge mode amplitude. A field dependent term is also found in the expression for power flow due to cross-coupling of the space-charge and the vortex modes, which may explain the reduction of noise figure with increasing magnetic field observed recently in traveling-wave amplifiers.
Author (TAB)

N68-18399# Michigan Univ., Ann Arbor. Dept. of Communication Sciences.
DECOMPOSITIONS OF AUTOMATA USING NORMAL SUBMONOIDS
Bernard Zeigler Dec. 1967 20 p refs
(Contracts DA-31-124-ARO(D)-483; Nonr-1224(21))
(TR-03105-50-T; AD-664143)

The series-parallel decomposition of automata is considered. The approach is both a simplification and generalization of certain of the constructions employed in the Krohn-Rhodes theory of decomposition. In particular the notion of decomposition by subnormal series to monoids is generalized and it is shown how to decompose group machines more efficiently than can be done using the Wreath product.
Author (TAB)

N68-18453# Harvard Univ., Cambridge, Mass. Div. of Engineering and Applied Physics.
SEMIANNUAL PROGRESS REPORT, JANUARY 1, 1967–JUNE 30, 1967
Nov. 1967 69 p refs Sponsored by NSF and NASA
(Contracts Nonr-1866(16); Nonr-1866(07); Nonr-1866(32))
(SAPR-74; AD-664239)

Contents: Very low frequency propagation; Electron and solid state physics; Automatic control; Communications and networks; Electronic devices for computer input and output; Microwave application of ferromagnetic and ferroelectric materials; Electromagnetic phenomena.
TAB

N68-18458# Aerospace Corp., El Segundo, Calif. Guidance Dynamics Dept.
THE SINGULARITY PROBLEM IN FINAL VALUE CONTROL
A. R. Stubberud Nov. 1967 30 p refs
(Contract F04695-67-C-0158)
(TR-0158(3307-02)-5; SAMSO-TR-68-26; AD-664319)

Final value control of linear plants is discussed. An expression for the closed-loop fundamental matrix is presented in terms of the open-loop transition matrix. It is shown that for scalar minimum-energy final value control the singularities in the feedback loops are inversely proportional to the order of the derivative being fed back; that is, the position loop has an nth order singularity, the velocity loop an (n-1)th order singularity, etc. A partially-closed-loop control is developed that allows the highest-order feedback singularity to be set between n and zero and the results are illustrated by examples.
Author (TAB)

N68-18500# Texas Univ., Austin. Dept. of Electrical Engineering.
ON THE CONSTRUCTION OF IRREDUCIBLE REALIZATIONS
H. D. Albertson and B. F. Womack 3 Nov. 1967 14 p refs Sponsored in part by Texas Instr., Inc.
(Grant AF-AFOSR-766-67)
(AFOSR-68-0234; AD-664595) CFSTI: HC $3.00/MF $0.65

This paper considers the problem of constructing an irreducible realization of a transfer-function matrix H(s), where one or more elements of H(s) contains multiple poles. An algorithm for constructing a realization using simple algebraic relationships is presented. In many cases, the realization obtained is irreducible, but in general it is not. A second algorithm presents a straightforward procedure for removing an uncontrollable and unobservable state variables from the realization obtained by Algorithm I, thus making it irreducible. An example illustrating the use of the algorithms is given.
Author (TAB)

N68-18540# Syracuse Univ. Research Inst., N. Y.
THEORY OF ADAPTIVE MECHANISMS. PART 1: SELECTED TOPICS IN AUTOMATA THEORY. PART 2: IDEALIZED MACHINES, FORMAL SYSTEMS, AND RECURSIVE FUNCTIONS Interim Report, 8 Aug. 1966–7 Aug. 1967
V. C. Hamacher, Frank R. Moore, Glen G. Langdon, and Robert G. Cantarella Griffiss AFB, N. Y. RADC Dec. 1967 222 p refs
(Contract F30602-67-C-0011)
(RADC-TR-67-521, V. 1; AD-664351)

In this project, the various subjects covered are: (1) Computational Complexity and Iterative Arrays, (2) A Generalized Firing Squad Problem, (3) Asynchronous Systems for Infinite Arrays, (4) Computer Theorem Proving, (5) Idealized Machines, Formal Systems, and Recursive Functions, (6) Simulation of Analog Computers on an Iterative Array Computer, (7) Firing Squad Simulation Program, (8) Matrix Multiplication on an Iterative Array, (9) An Iterative Array Pseudo-Random Number Generator, (10) A Supplement to RADICAL Manual. The studies are issued in four separate interim technical reports: (1) through (4), (5), (6) through (9), and (10) are the groupings. Part II - The theories of Turing machines, W-machines, Markov Algorithms, Post System, Recursive Functions, and the Calculus of Lambda Conversion are presented. Each of these has in common the use of a finite alphabet, a finite number of rules, and a potentially infinite amount of working space, and each may be considered as a special case of a general theory of algorithms.
TAB

N68-18553# Texas Univ., Austin. Labs. for Electronics and Related Science Research.
ADAPTIVE CONTROL OF UNKNOWN TIME VARIABLE SYSTEMS
M. K. Masten and B. F. Womack 1967 12 p refs Presented at the 1st Asilomar Conf., Pacific Grove, Calif., 1–3 Nov. 1967
(Grant AF-AFOSR-766-67)
(AFOSR-68-0233; AD-664594)

The problem of controller design for unidentified time variable systems is considered. The adaptive solution obtained does not identify the unknown plant; rather a low order linear model is determined whose behavior is near that of the plant. The model characteristics are assumed sufficiently similar to those of the plant so that controller synthesis based on information gained from the model will be adequate for plant control. The model must be rapidly determined since the plant is time variable; time intervals in which the model is not an accurate approximation of the plant represent periods of inferior control. The adaptive rate at which the model is determined is considered and a scheme which will provide rapid adaptation is determined. Author (TAB)

N68-18580# Joint Publications Research Service, Washington, D. C.

STATISTICAL THEORY OF AUTOMATIC LEARNING SYSTEMS

V. S. Pugachev *In its* Tech. Cybernetics 5 Mar. 1968 p 35–59 refs Presented at Gen. Moscow Seminar on Statis. Probl. of Cybernetics at the Inst. of Automation and Telemech., 15 Apr. 1965 and 24 Feb. 1966 (See N68-18577 09-19)

The problem of training automatic systems was investigated as the problem of training an arbitrary data processing process, the control or making of decisions with any "teacher" algorithms. A detailed discussion of the results obtained is presented here with examples. The process of training an automatic system in the general case reduces to finding and progressively refining unknown characteristics of the signals, noise and controlled members. Optimal training algorithms with various training procedures and optimal teacher algorithms are defined. The training results are investigated as a function of the quality of operation of the teacher. The general properties of the optimal training process are established. Author

N68-18586# Joint Publications Research Service, Washington, D. C.

RELIABILITY OF A DUPLICATED SYSTEM WITH LIMITED REPAIR

B. A. Miskevich *In its* Tech. Cybernetics 5 Mar. 1968 p 109–118 refs (See N68-18577 09-17)

A system of equally reliable elements having unloaded reserve and ZIP [a set of spare parts, instruments and attachments] is investigated. The graph of conversion of the system from one graph to another is a branched process. For the investigated case the system of differential equations is compiled and solved under the assumption that the time of fail-free operation of the elements and the repair time are distributed according to an exponential law, and the formula is derived for the probability of fail-free operation of the system. Author

N68-18587# Joint Publications Research Service, Washington, D. C.

DETERMINATION OF THE PROBABILITY OF FALSE FAILURE IN AUTOMATIC MONITORING

V. S. Zaritskiy and L. S. Sonin *In its* Tech. Cybernetics 5 Mar. 1968 p 119–127 refs (See N68-18577 09-19)

A method is investigated for determining the probability of false failure during monitoring. The probability is defined as a function of the tolerance field of the controlled parameter, errors in the monitoring apparatus and the monitoring time T. Tables are presented which may be used to approximate the indicated probability without awkward calculations. As an example the probability of occurrence of a false failure during the monitoring time T is defined in the case where the correlation error function of the monitoring apparatus has the form $K(\tau)=\sigma^2 e^{-\alpha|\tau|}$, and the law of distribution of the controlled parameter is normal. Author

N68-18588# Joint Publications Research Service, Washington, D. C.

GRAPHICO ANALYTIC METHOD OF EVALUATING THE QUALITY OF DIGITAL AUTOMATA DESIGNS

Ye. A. Drozdov *In its* Tech. Cybernetics 5 Mar. 1968 p 128–136 refs (See N68-18577 09-19)

A graphico-analytical method ensuring selection of the optimal structure of a digital automaton taking into account the restrictions imposed on the values of its parameters is investigated. The possibility of determining the requirements imposed on the elements of the automaton is indicated. Author

N68-18594# Joint Publications Research Service, Washington, D. C.

A METHOD OF SYNTHESIS OF SELF ADJUSTING STABILIZATION SYSTEMS FOR DYNAMIC CHARACTERISTICS

A. I. Petrov and V. I. Kukhtenko *In its* Tech. Cybernetics 5 Mar. 1968 p 195–207 refs (See N68-18577 09-19)

A method of finding the statistically optimal self-adjusting system designed for stabilization of the dynamic characteristics of the basic circuit of a control system is investigated. The conditional mathematical expectation of the function (or functional) of deviation from the given value of some controlled parameter characterizing the dynamic properties of the control system with fixed realizations of the input and output variables of the basic circuit is taken as the quality criterion. Author

N68-18595# Joint Publications Research Service, Washington, D. C.

AN EXTREMAL SYSTEM OF THE STEP TYPE WITH AN INERTIAL OBJECT

N. N. Leonov *In its* Tech. Cybernetics 5 Mar. 1968 p 208–221 refs (See N68-18577 09-19)

The dynamics of a single channel extremal system with an inertial object and with a step type optimizer are investigated. The quality of operation of the investigated system is studied (the quality of the processes of finding and following extremal values of the object output). One of the means of eliminating some disadvantages of operation of the investigated system is considered. Author

N68-18793# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

CYBERNETICS AND COMPUTER TECHNOLOGY (COLLECTION OF ARTICLES)

31 Mar. 1967 123 p refs Transl. into ENGLISH of the book "Kibernetika i Vychislitel'naya Tekhnika" Kiev, Naukova Dumka, 1964 p 1–120
(FTD-MT-65-551; AD-663911)

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2. CERTAIN INFORMATIONAL CRITERIA IN THE CONTROL OF MULTIPLE-CONNECTED SYSTEMS K. D. Zhuk p 7–15 refs (See N68-18795 09-10)

3. CONTROL SYNTHESIS OF ARITHMETICAL UNIT OF A DIGITAL COMPUTER V. I. Kartashev p 17–24 ref (See N68-18796 09-08)

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5. GENERATOR OF FUNCTIONS FOR THE SOLUTION OF INTEGRAL EQUATIONS IN ELECTRONIC MODELS A. F. Verlan' p 31–35 refs (See N68-18798 09-10)

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9. CERTAIN QUESTIONS OF EXPLOITATIONAL RELIABILITY OF DIGITAL CALCULATING AND CONTROLLING MACHINES L. A. Korytnaya p 63–74 refs (See N68-18802 09-08)

10. CERTAIN METHODS OF PRIMARY TREATMENT OF SOUND INFORMATION V. G. Zaytsev p 76–81 refs (See N68-18803 09-07)

11. SELECTION OF THE TYPE OF STANDARDS FOR CORRELATION READING AUTOMATA V. K. Yeliseyev p 83–89 refs (See N68-18804 09-08)

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13. QUESTION OF AUTOMATIC TREATMENT OF SOUND INFORMATION V. G. Zaytsev p 97–107 refs (See N68-18806 09-07)

14. CALCULATION OF PHOTOELECTRIC SYSTEMS WITH SCANNING BEAM V. K. Yeliseyev p 109–116 refs (See N68-18807 09-10)

15. INVESTIGATION OF HIGH SPEED OPTIMUM OPERATION OF SYSTEMS OF THE SECOND ORDER (A CASE OF COMPLEX-CONJUGATE ROOTS OF A CHARACTERISTIC EQUATION OF THE LINEAR PART) D. V. Karachenets p 117–124 refs (See N68-18808 09-10)

N68-18795# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

CERTAIN INFORMATIONAL CRITERIA IN THE CONTROL OF MULTIPLE-CONNECTED SYSTEMS [NEKOTORYYE INFORMATSIONNYYE KRITERII V UPRAVLENII MNOGOSUYAZNYMI SISTERMAMI]

K. D. Zhuk *In its* Cybernetics and Computer Technol. 31 Mar. 1967 p 7–15 refs (See N68-18793 09-10)

The results are presented on a study of the synthesis of multiply connected combined systems that considered informational criteria (quantity, control, speed of flow, and others). Using a previously developed classification of the structures of automatic multiply-connected systems (AMS) it is shown that all three canonical structures (P, V and H) are particular cases of a full operator of AMS, $H = (E + \overline{M})^{-1} (W + M)$ or can be obtained from the full equation $X = (E + \overline{M})^{-1} (W + M) \Phi$ if all the elements of operator H that correspond to torn connections in the system are reduced to zero. Cases in which it is possible to synthesize qualitative AMS when the number of outputs is not equal to the number of inputs are shown. Author

N68-18797# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ON THE METHOD OF SYNTHESIS OF AUTOMATIC MULTICIRCUIT SYSTEMS [OB ODNOM METODE SINTEZA AUTOMATICHESKIKH MNOGOKONTURNYKH SISTEM]

K. D. Zhuk *In its* Cybernetics and Computer Technol. 31 Mar. 1967 p 25–30 refs (See N68-18793 09-10)

Using the method of inverse operators, the solution is simplified to the problem of synthesizing qualitative automatic multiply-connected systems (AMS), through the use of a more general criterion. The theoretical feasibility criterion of synthesized AMS is the existance of the inverse operator of the object, which leads to correspondence of input and output signals. The method of inverse operators consists of constructing closed AMS in which an n-dimensional device in feedback converts discrepancies (input signals) into controlling actions. Author

N68-18798# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

GENERATOR OF FUNCTIONS FOR THE SOLUTION OF INTEGRAL EQUATIONS IN ELECTRONIC MODELS [GENERATOR FUNKTSIY DLYA RESHENIYA INTEGRAL'NYKH URAVENENIY NA ELEKTRONNYKH MODELYAKH]

A. F. Verlan' *In its* Cybernetics and Computer Technol. 31 Mar. 1967 p 31–35 refs (See N68-18793 09-10)

Based on the use of analog computers, a solution is proposed to such integral equations as the Fredholm equation of the second order, where it becomes necessary to generate analogs of the free term and of the kernel. A formula for the approximate solution is derived so that the modeling of the kernel reduces to the construction of a unit capable of generating a family of functions approximating the initial function of two variables. Details are given on a function generator consisting of a grid of voltage dividers, stepping selectors, an integrator, and control circuits. This function generator makes it possible to solve the equation by successive approximations. Also described are modifications of the generator, permitting the use of the more rapidly converging Gauss–Seidel method, and approximation of the initial equation by means of a system of algebraic equations derived from the formula for the approximate solution. It is claimed that the function generator can be easily adjusted and constructed from elements widely used in analog computer technology. Author

N68-18799# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ON ONE PARTICULAR LAW OF OPTIMUM CONTROL REGARDING HIGH SPEED OPERATION [OB ODNOM CHASTNOM ZAKONE OPTIMAL'NOGO PO BYSTRODEYSTVIYU UPRAVLENIYA]

A. A. Snegur and A. D. Semenyuk *In its* Cybernetics and Computer Technol. 31 Mar. 1967 p 37–41 refs (See N68-18793 09-10)

It is assumed that there is a controlled object, whose law of motion is based on a linear system of differential equations, and that the system satisfies conditions of existence and uniqueness theorems, and the theorem of control intervals. The following theorem is stated and proved: If the system of differential equations of n-th order possesses zero roots of characteristic equation, then for optimum (high speed operation) transition from the beginning of coordinates of phase space in point $(X_1, 0, ..., 0)$, the relationship of durations of control intervals does not depend on the value of jump along coordinate X_1. It is pointed out that the advantages of this control law are its simplicity due to eliminating the need of measuring the derivatives from the controlled coordinate in the control process. Its deficiencies are cited as the necessity of readjustment at the end of the transition process by some law of stabilization. M.G.J.

N68-18800# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

INVESTIGATION OF OPTIMUM (BY HIGH SPEED OPERATION) SYSTEMS OF THE SECOND ORDER: THE CASE OF REAL ROOTS [ISSLEDOVANIYE OPTIMAL'NYKH PO BYSTRODEYSTVIYU SISTEM VTOROGO PORYADKA (SLUCHAY DEYSTVITEL'NYKH KORNEY)]

D. V. Karachenets and V. V. Kolesnik *In its* Cybernetics and Computer Technol. 31 Mar. 1967 p 43–51 refs (See N68-18793 09-10)

Consideration is given to the construction of a system of optimal (high-speed operation) control of an object whose behavior is described by a linear second order differential equation with zero and real roots of the characteristic equation. Because of the reality of the roots of the characteristic equation, the conditions of the theorem of n intervals and the concepts of phase space and switching hypersurface (phase plane and line of optimum switching for second order systems) are satisfied. The basic idea of the proposed approach is that, if the position of the depicted point of the object in the phase space and the position of switching hypersurface are known, the sign of control at each moment, i.e.,

the optimum for controlling the object, can be determined. The device that performs control of the object is shown and described. Experiments conducted with this device showed complete efficiency of the system for the given form of effects. Author

N68-18807# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CALCULATION OF PHOTOELECTRIC SYSTEMS WITH SCANNING BEAM [K RASCHETU FOTOELEKTRICHESKIKH SISTEM S BEGUSHCHIM LUCHOM]
V. K. Yeliseyev *In its* Cybernetics and Computer Technol. 31 Mar. 1967 p 109–116 refs Presented at the NTORiE Conf., Kiev, May 1962 (See N68-18793 09-10)

The system considered is one in which a light spot from a cathode ray tube screen is projected by a lens onto a flat surface, and its reflection picked up with a photomultiplier and converted into an electric voltage and current. An expression is derived for the signal/noise ratio as a function of the illumination intensity and parameters characterizing the properties of the optical system and of the photomultiplier. A procedure is then indicated for designing optical systems of this type to meet a specified signal/noise ratio. Difficulties arising when an attempt is made to increase the field of view of the optical system are discussed. In the latter case, account must be taken of the distortion introduced by the variation of the transmission field of view. Ways of eliminating this distortion are suggested. Author

N68-18808# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INVESTIGATION OF HIGH SPEED OPTIMUM OPERATION OF SYSTEMS OF THE SECOND ORDER (A CASE OF COMPLEX-CONJUGATE ROOTS OF A CHARACTERISTIC EQUATION OF THE LINEAR PART) [ISSLEDOVANIYE OPTIMAL'NYKH PO BYSTRODEYSTVIYU SISTEM VTOROGO PORYADKA (SLUCHAY KOMPLEKSNO SOPRYAZHENNYKH KORNEY KHARAKTERISTICHESKOGO URAVNENIYA LINEYNOY CHASTI)]
D. V. Karachenets *In its* Cybernetics and Computer Technol. 31 Mar. 1967 p 117–124 refs (See N68-18793 09-10)

Details are given on a relay system of automatic adjustment whose linear part is described by a second order differential equation with complex-conjugate roots of the characteristic equation. To synthesize a high-speed optimum control operation, the method of reproducing the optimal curve of switching through a model working in an accelerated time scale is used. The structure and the operation of the device synthesizing the optimum control are studied in detail in the case of a quasi-stationary curve of switching of the sign of the relay signal. The diagram of the device and the limiting conditions on the controlled object are given. Author

N68-18811*# Brown Univ., Providence, R. I. Div. of Applied Mathematics.
RESEARCH IN THE GENERAL AREA OF NON-LINEAR DYNAMICAL SYSTEMS Final Report, 8 Jun. 1965–8 Jun. 1967
Henry Hermes, J. J. Hurt, E. F. Infante, J. P. La Salle, K. R. Meyer et al 20 Jun. 1967 454 p refs
(Contract NAS8-11264)
(NASA-CR-61632) CFSTI: HC $3.00/MF $0.65 CSCL 09C

Summary information is presented on the research conducted in the areas of control theory, systems stability, the invariance principles, electrical network theory, Liapunov functions, periodic solutions, Volterra and functional integral equations, and contact transformations. Detailed reports are included on each subject. Important areas for future research are identified as the stability of time-varying systems, and of dynamical systems defined by partial differential equations; dynamic programming via Liapunov's direct method; and choice of performance criterion. M.G.J.

N68-18961* Purdue Univ., Lafayette, Ind. Electronic Systems Research Lab.
THE EFFECT OF PHASE DETECTOR CHARACTERISTICS ON PHASE LOCK LOOP DESIGN PARAMETERS
John J. Uhran and John C. Lindenlaub [1966] 26 p refs Presented at the Intern. Symp. on Inform. Theory, Los Angeles, 31 Jan.–2 Feb. 1966
(Grant NsG-553)
(NASA-CR-69972) CSCL 09C

The effect of different phase detectors or comparators on the performance of a first order phase-lock loop was investigated, and a set of criteria was established as a basis for making a comparison among systems. Functions considered included the sine, sawtooth, tanlock, square tanlock, n^{th} order tanlock, Trig Fcn 1, and Trig Fcn 2; and each was normalized to have a slope of unity at x = o, to be periodic at 2, and to be odd. Tanlock was found to be superior to the sine comparator in every respect, although other functions outperformed tanlock. M.W.R.

N68-19202 Texas Univ., Austin.
ACTIVE NETWORK SYNTHESIS USING PRACTICAL AMPLIFIERS
Ray Earl Cooper (Ph.D. Thesis) 1967 120 p
Available from Univ. Microfilms: HC $3.00/MF $3.00 Order No. 67-8098

Two synthesis procedures are presented for active RC common ground networks. The active elements used are practical amplifiers having finite input and output impedances and gain. These amplifiers are more easily realized than are ideal elements such as negative impedance converters, gyrators, and negative resistors. Active RC networks are particularly appealing for use in microcircuits and low frequency applications where inductors are not practical. The two-amplier method allows the synthesis of any real rational voltage transfer function. The single amplifier method realizes voltage transfer functions with poles in the left-half-plane and zeros any place except the positive real axis. The finite amplifier parameters place upper and lower bounds on the required passive structures. Provision for a load resistance was made in the synthesis procedures. Dissert. Abstr.

N68-19229*# Douglas Aircraft Co., Inc., Newport Beach, Calif.
RESEARCH ON THE UTILIZATION OF PATTERN RECOGNITION TECHNIQUES TO IDENTIFY AND CLASSIFY OBJECTS IN VIDEO DATA Final Report
Washington NASA Mar. 1968 285 p refs
(Contract NAS12-30)
(NASA-CR-999; SM-48464-F) CFSTI: HC $3.00/MF $0.65 CSCL 09F

The study consisted of a literature survey to select pattern recognition methods for testing, controlled recognition experiments to test the performance of the selected methods on five specimen classification tasks, and a hardware feasibility study, culminating in three potential designs for a spaceborne recognition system. Six methods for generating property filters and eight algorithms for designing decision functions were tested. Lunar photographs and Nimbus pictures of cloud patterns were used in the experiments. Decision networks were designed to perform three recognition tasks on the photographic data. Three recognition systems were designed: (1) parallel/analog, (2) sequential/hybrid, and (3) sequential/digital. Each has an image dissector tube which views the scene and scans the sensed image through a small aperture. The first implements all property filters separately in analog form. The second uses a single property filter repetitively with a diode matrix containing the weighting elements for each computed property. The third uses a compact core storage unit and an arithmetic unit with a combination hardware and software program to implement the required property filters. All three systems can classify TV pictures in real time. Author

N68-19253 Arizona State Univ., Tempe.
METHODS FOR SOLVING OPTIMUM CONTROL PROBLEMS USING PONTRYAGIN'S MAXIMUM PRINCIPLE
Max Darwin Anderson (Ph.D. Thesis) 1967 128 p
Available from Univ. Microfilms: HC $6.20/MF $3.00 Order No. 67-7357

A simple method for solving optimum control problems by Pontryagin's Maximum Principle has been developed. It consists of unconstraining the state variables, and then solving the problem backwards in time. An analog computer with repetitive operation has sufficient capability for solving problems by this method. The result is that complicated parameter searching methods, which can only be used on a hybrid computer, have been avoided. In addition, problems with constraints on the final states of the system can be solved. The method has been applied to eight examples, three of which are nonlinear problems. Dissert. Abstr.

N68-19260*# Brown Univ., Providence, R. I. Center for Dynamical Systems.
A REPORT ON SESSION 12 IFAC CONGRESS, 1966
J. P. LaSalle 1966 10 p
(Grant NGR-40-002-015)
(NASA-CR-76591) CFSTI: HC $3.00/MF $0.65 CSCL 09C

This report contains the following brief discussions or abstracts of papers presented at the conference: (1) engineering philosophy of optimization in analytical design problems of optimal controllers; (2) the absolute stability of a nonautonomous system of difference equations that is asymptotic in a restricted sense to a discrete Lurie system; (3) the application of the Lurie technique to the stability of two classes of nonlinear multivariable control systems; (4) remarks on the theory of the invariance and autonomy in multidimensional, essentially nonlinear control systems; (5) a method for estimating nonlinear transfer systems from plotted step responses; (6) a theory on the energetic stability of nonlinear systems; and (7) linearization of a nonlinear problem using a dual input describing function, and criteria for determining the stability of asynchronous simultaneous oscillations in nonlinear systems. K.W.

N68-19267*# Rensselaer Polytechnic Inst., Troy, N. Y.
SENSITIVITY DESIGN TECHNIQUE FOR OPTIMAL CONTROL, PART C Final Report
Rob Roy and J. H. Billings Oct. 1967 16 p refs
(Grant NGR-33-018-014)
(NASA-CR-93527) CFSTI: HC $3.00/MF $0.65 CSCL 09C

A feasibility study is described which was conducted to investigate the possibility of using optimal sensitivity design techniques to design a feedback control system for a large, flexible booster. The vehicle to be controlled is also described. The design objective is to maintain the vehicle in the immediate neighborhood of a predefined nominal trajectory in spite of disturbances acting on the vehicle. These disturbances are both external, such as random wind gusts, and internal such as changes in vehicle parameters. An additional design objective is to keep the bending of the vehicle within design limits, preferably as small as possible. The nominal trajectory of the vehicle is described by a set of nonlinear differential equations. However, small perturbations of the vehicle's motion about the nominal can be adequately characterized by a set of linear incremental differential equations with time varying coefficients. Author

N68-19305 IIT Research Inst., Chicago, Ill.
EQUIRIPPLE APPROXIMATION FOR NETWORKS WITH PRESCRIBED FREQUENCY CHARACTERISTICS
Kenneth Wilson Haag (Ph.D. Thesis) 1967 121 p
Available from Univ. Microfilms: HC $6.00/MF $3.00 Order No. 67-7026

This study is concerned with frequency transformations applicable to the equiripple Cauer parameter functions which are used in the insertion loss design of filters. Two types of transformations are studied: a) Transformations which change the order of the filter function but do not change the type of filter characteristic. b) Transformations which change the type of filter characteristic. A graphical solution is presented which relates passband and stopband attenuations to the order of the filter function and the transition region width. Each of the above values can be read directly from the graph. Dissert. Abstr.

N68-19382*# Brown Univ., Providence, R. I. Div. of Applied Mathematics.
RESEARCH IN THE GENERAL AREA OF NON-LINEAR DYNAMICAL SYSTEMS Final Report, 8 Jun. 1965–8 Jun. 1967
Henry Hermes, J. J. Hurt, E. F. Infante, J. P. La Salle, K. R. Meyer et al 20 Jun. 1967 390 p refs
(Contract NAS8-11264)
(NASA-CR-61629) CFSTI: HC $3.00/MF $0.65 CSCL 09C

Summary data are presented on the mathematical solution of problems related to nonlinear, dynamic systems. Areas in which work was reported include: control theory, system and point stability, electrical network theories, invariance principles for differential equations, and contact transformations. An appendix contains the papers and reports generated by this research. Some of the papers have been published and references to their publications are given. In other cases the papers have been accepted or submitted for publication and the journals in which they are to appear are noted. E.J.S.

N68-19388*# Harvard Univ., Cambridge, Mass. Div. of Engineering and Applied Physics.
NEW SECOND-ORDER AND FIRST-ORDER ALGORITHMS FOR DETERMINING OPTIMAL CONTROL: A DIFFERENTIAL DYNAMIC PROGRAMMING APPROACH
D. H. Jacobson Feb. 1968 51 p refs
(Grant NGR-22-007-068; Contracts N00014-67-A-0098-0006; N00014-67-A-0298-0005; N00014-67-A-0298-0008)
(NASA-CR-93690; TR-551) CFSTI: HC $3.00/MF $0.65 CSCL 09C

The notion of differential dynamic programming is used to develop new second-order and first-order successive approximation methods for determining optimal control. The unconstrained, non-linear control problem is first considered, and a second-order algorithm is developed which has wider application than existing second-variation and second-order algorithms. A new first-order algorithm emerges as a special case of the second-order one. Control inequality constraints are introduced into the problem and a second-order algorithm is devised which is able to solve this constrained problem. It is believed that control constraints have not been handled, previously, in this way. Again, a first-order algorithm emerges as a special case. The usefulness of the second-order algorithms is illustrated by the computer solution of three control problems. The methods presented were extended to solve problems with terminal constraints and implicitly given final time. Author

N68-19469# Technische Hochschule Munchen (West Germany).
TRANSIENT WAVES EXPANSION FOR DIFFERENTLY ARRANGED OPEN WIRE CIRCUITS FORM OF THE TRANSIENT OSCILLATION POTENTIAL IN CASE OF SHORT-LINE FAULTS [AUSBREITUNG VON WANDER-WELLEN BEI VERSCHIEDENEN ANORDNUNGEN VON FREILEITUNGEN IM HINBLICK AUF DIE FORM DER EIN-SCHWINGSPANNUNG BEI ABSTANDSKURZSCHLUESSEN]
Herbert Karrenbauer (Ph.D. Thesis) 1967 143 p refs In GERMAN
CFSTI: HC $3.00/MF $0.65

The purpose of this work is to determine the independent transient voltage curve in case of short-line fault for the entire time interval during which reciprocal action occurs between the circuit

and the circuit breaker. Assuming ideal conductivity of the ground and the conductors, the Laplace transformation and the heterodyne method are initially used. The resulting transient voltages are treated first as infinite series of transient waves and then as infinite series of natural oscillations. Single-phase artificial conductors are derived from concentrated elements. The time response of the transient voltage is obtained by Fourier analysis. Measurements on experimental transmission lines were conducted in order to compare the results with those obtained by the calculations.

Transl. by K.W.

N68-19474 Texas Univ., Austin.
CHARACTERISTICS OF THE STEADY-STATE SOLUTIONS OF A CLASS OF NONLINEAR SYSTEMS
Jimmy Howard Akin (Ph.D. Thesis) 1967 128 p
Available from Univ. Microfilms: HC $6.20/MF $3.00 Order No. 67-8086

A study is made of a class of nonlinear systems commonly known as Duffing systems. The systems are linearly-damped and harmonically-forced with moderately large nonlinearity. Prime interest is centered on determining the characteristics of the harmonic components of the steady-state solution of the differential equation of motion. In order to more fully determine the characteristics of the components of the steady-state solutions, an experimental investigation is made. Analog models of the systems are simulated on a dc analog computer. The steady-state solutions are represented by a ten term Fourier series. The experimental investigations are conducted over wide ranges of system parameters. Response curves of the harmonic, super harmonic, and subharmonic components of the steady-state solutions are plotted and presented. Also presented are the phase angles of these components relative to the forcing function. Dissert. Abstr.

11 FACILITIES, RESEARCH AND SUPPORT

Includes airports; lunar and planetary bases including associated vehicles; ground support systems; related logistics; simulators; test facilities (e.g., rocket engine test stands, shock tubes, and wind tunnels); test ranges; and tracking stations.

N68-18456# Kaiser Engineers, Oakland, Calif.
EARLY BLOWDOWN (WATER HAMMER) ANALYSIS FOR LOSS OF FLUID TEST FACILITY
Stanislav Fabic Apr. 1967 107 p refs Revised
(Contract AT(10-1)-1165)
(TID-24137) CFSTI: HC $3.00/MF $0.65

During the early part of the reactor coolant blowdown rarefraction (acoustic) waves propagate through the system in the same fashion as during the water-hammer in the liquid filled piping system, initiated by the sudden opening of a gate valve. However, since the loss of liquid causes the local pressures to drop below saturation, evaporation takes place at the exit and gradually spreads throughout the system. Water-hammer may persist in the part of the system that still contains liquid. The analysis applicable to the blowdown-induced water-hammer, where transition to the two-phase blowdown takes place is formulated. The well-known water-hammer equations for the liquid filled pipes are first deduced from the basic conservation laws. The wave superposition method is then described, applicable to the solutions, first of the liquid filled systems and, second, of the systems in which the phase change is occurring. The method described could be interfaced with Kaiser's two-phase blowdown analysis but this was not attempted. Instead, a digital computer program is described for the frictionless form of the wave superposition method which applies to blowdown only until the steam phase has started to form. Flow charts, Fortran listing, and a sample problem are included. Author (NSA)

N68-18460*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
SNAP-8 SIMULATOR LOOP MECHANICAL DESIGN
Alfred S. Valerino, James C. Wood, and Joseph F. Reznik Washington NASA Mar. 1968 65 p refs
(NASA-TM-X-1515) CFSTI: HC $3.00/MF $0.65 CSCL 14B

A SNAP-8 system simulation facility was designed, assembled, and tested. Design flow rates of the three-loop system were 32,000 lb/hr of eutectic NaK in both the primary and heat-rejection loops and 9100 lb/hr of Hg in the power loop. The turbine, radiator, and nuclear reactor were simulated. A prototype boiler and condenser were employed. Fluid circulation was obtained by electromagnetic pumps and a centrifugal pump for NaK and Hg, respectively. Test results indicated errors in Hg vapor flow rate due to erosion and/or corrosion of the entrance and throat sections of choked venturis. The location of spark-plug-type liquid-level indicators in the expansion tanks of the NaK loops resulted in frequent shorting of the indicators. Gas and vacuum lines located atop the tanks were often plugged. Metal flexible hoses installed to alleviate thermal expansion of the piping by lateral movement of the hoses were safely employed in the liquid metal loops. The NaK electric heater employed as the heat source in the primary loop was replaced because of external leaks and electric shorting of the heater-element lead wires. Author

N68-18482# Gosudarstvennyi Komitet Po Ispolzovaniyu Atomnoi Energii, Moscow (USSR). Institut Teoreticheskoi i Eksperimental'noi Fiziki.
ADJUSTMENT OF ACCELERATION CONDITIONS AND THE BEAM PARAMETERS OF THE LINEAR ACCELERATOR I-2 [NALADKA REZHIMA USKORENIYA I PARAMETRY PUCHKA LINEINOGO USKORITELYA I-2]
V. A. Batalin, I. M. Kapchinskii, N. V. Lazarev, V. K. Plotnikov, and B. I. Polyakov 1967 23 p In RUSSIAN; ENGLISH summary
(ITEF-513)

A linear strong-focusing proton accelerator was put in operation at the Institute for Theoretical and Experimental Physics. The 24.6-MeV proton beam with the pulsed current up to 130 ma was obtained. The methods of starting, the operations used for the beam intensity increase as well as the characteristics of the beam and the conditions of linac are given. The instrumentations used for the beam measurements are described. Author (NSA)

N68-18490# General Electric Co., Cincinnati, Ohio. Aircraft Engine Technical Div.
MODEL FREON COMPRESSOR ACOUSTICAL STUDIES Final Report, 1966–1967
R. J. Wells and J. M. McGrew Feb. 1968 261 p refs
(Contract FA-67-WA-1638)
(FAA-DS-68-5) CFSTI: HC $3.00/MF $0.65

Development was continued on the scale model Freon compressor facility for investigation of compressor/fan acoustics by improvements to the test loop, addition of exhaust noise measurements, improved instrumentation, automation of data reduction, and generalization of model/full-scale scaling laws over five gases and a wide range of operating conditions. Full-scale, high Mach number fan aerodynamic performance can be adequately simulated and reasonable correlation obtained between scale-model and full-scale acoustic performance. Both minor and major variations in blade/vane spacing were evaluated as were variations in vane number; both investigations led to new results. Fans of two different aerodynamic designs were investigated and new results obtained regarding the dependency of fan noise on rotational speed. Duct probe and far-field acoustic power determinations were compared conditionally. Author

N68-18560# Oak Ridge National Lab., Tenn. Electronuclear Div.

HIGH-ENERGY ACCELERATORS, 1967

Fred T. Howard Nov. 1967 43 p refs

(Contract W-7405-ENG-26)

(ORNL-AIC-1) CFSTI: HC $3.00/MF $0.65

The chief characteristics of over 40 major accelerator installations of the world are given: 21 proton synchrotrons, 12 electron synchrotrons, 6 linear accelerators, and 2 large isochronous cyclotron projects. Full-page data sheets described each high energy ($E \leq 1$ GeV) accelerator, existing or under construction. Proposed machines are briefly described in tabulations for the various types. The characteristics of 7 injectors and 17 storage rings are also tabulated. Author (NSA)

N68-18832*# General Electric Co., Daytona Beach, Fla. Apollo Support Dept.

REQUIREMENTS SPECIFICATION PART 1 AND ANALYSIS OF DYNAMIC SIMULATION METHODS FOR LAUNCH VEHICLE COMPONENT LEVEL SIMULATION

Mar. 1966 153 p refs

(Contract NAS8-20060)

(NASA-CR-61624) CFSTI: HC $3.00/MF $0.65 CSCL 22D

The Launch Vehicle Component Level Simulation (LVCLS) computer program requirements specification is described. The LVCLS computer program is an exceptionally flexible engineering tool which can be used to select hardware systems and conditions for simulating problems specified at the time of use. Standard computational modules are related to each launch vehicle or ground support equipment system for use in an automatic mode of operation. Where the user requires more accuracy, less running time or otherwise wishes to select a different available computational method for use on a particular problem, he may directly input his requirements and override most normal combinations. Several proposed methods of solving the dynamic equations of the LVCLS were compared on a representative portion of the Inertial Measurement Unit. The results showed that no one method stands out as being superior in all cases. A proper combination of methods for different portions of the system will give optimum results. R.N.A.

N68-18975# General Electric Co., Philadelphia, Pa. Missile and Space Div.

STUDY OF A CONTINUOUS DISCHARGE DRIVER/NON-REFLECTED/FREE PISTON SHOCK TUNNEL

C. H. Marston and W. R. Warren Jan. 1968 57 p refs

(R68SD1)

A concept for a shock tunnel capable of generating a short duration (≈ 1 ms), large scale, high velocity, high density air flow with near equilibrium chemical simulation of free stream flight conditions is described. The facility is a nonreflected shock tunnel in which electrical energy from a large capacitor bank is discharged into a short helium filled driver. When the diaphragm ruptures, the test gas is heated, compressed and accelerated by the incident shock wave. The driver discharge is continued after diaphragm rupture to help maintain the incident shock wave velocity at its initial value for the desired test duration. The test gas flow behind the incident shock wave is expanded in a nozzle, the first section of which may be an MHD accelerator. A theory describing the operation of the facility and results of illustrative performance calculations are presented. It is shown that this facility offers a significant improvement in test flow properties compared to practical extensions of existing devices. Author

N68-19059# Royal Aircraft Establishment, Farnborough (England).

FOG DISPERSAL OVER AIRPORT RUNWAYS BY A MECHANICAL METHOD [NEBELBESEITIGUNG UEBER LANDEBAHNEN AUF FLUGPLAETZEN MIT HILFE EINES MECHANISCHEN ENTNEBELUNGS-VERFAHRENS]

U. Schmieschek Oct. 1967 17 p ref Transl. into ENGLISH from German Report DLR-FB-67-23, Mar. 1967

(RAE-LIB-TRANS-1257; DLR-FB-67-23) CFSTI: HC $3.00/MF $0.65

Following a description of a fog dispersal procedure employing rotary sieves and after a brief résumé of fog dispersal experiments in the laboratory, a mobile plant for dispersing fog on airfield runways is described. Fog dispersal experiments were carred out under natural fog conditions and proved successful in considerably increasing the visibility. Author

N68-19091*# General Electric Co., Philadelphia, Pa. Missile and Space Div.

VOYAGER SPACECRAFT PHASE B, TASK D. VOLUME 4: ENGINEERING TASKS. BOOK 2: APPLICABILITY OF APOLLO CHECKOUT EQUIPMENT Final Report

16 Oct. 1967 223 p refs

(Contract NAS8-22603)

(NASA-CR-93565; DIN-67SD4379, V. 4, Bk. 2) CFSTI: HC $3.00/MF $0.65 CSCL 22D

The checkout system and support equipment in use at the Kennedy Space Center on the Saturn/Apollo program were assessed to determine the extent of applicability to the Voyager program. The equipment considered included Apollo's acceptance checkout equipment (ACE-S/C), the Saturn electrical support equipment, and the Apollo and Saturn mechanical and fluid ground equipment. Voyager launch equipment requirements are discussed, and the Voyager spacecraft interface equipment is described. Data sheets on the recommended Voyager-applicable Apollo/Saturn mechanical and fluid ground equipment are included. Necessary modifications are determined, and their cost and feasibility are established. The findings show that only ACE has a significant degree of applicability. M.G.J.

N68-19207*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

OUTGASSING OF WATER VAPOR FROM CONCRETE SURFACES IN VACUUM ENVIRONMENT

Adolph C. Spagnuolo and Edward A. Maslowski Washington Mar. 1968 11 p refs

(NASA-TM-X-1536) CFSTI: HC $3.00/MF $0.65 CSCL 14B

The amount of water loss by outgassing from two borated and two nonborated concrete blocks was measured at vacuum levels of 0.1 and 30 torr (1.3×10^1 and 3.9×10^3 N/m^2). The nonborated blocks were also baked out in a furnace and subsequently placed in a 100-percent humidity chamber to investigate the reabsorption power of the concrete. The amount of water loss proved to be approximately 0.06 lb/ft^2 (0.03 kg/m^2) for the nonborated and 0.320 lb/ft^2 (0.16 kg/m^2) for the borated blocks. The concrete reabsorbed 70 percent of the water loss within the first 20 hours in the 100-percent humidity chamber. Author

N68-19288# Sandia Corp., Albuquerque, N. Mex.

CONTROL OF BERYLLIUM DURING IMPACT TESTS

A. Juskiewicz and C. P. Skillern Nov. 1967 13 p

(SC-TM-67-827) CFSTI: HC $3.00/MF $0.65

Beryllium was shattered in an air gun during an experiment. To control the beryllium particles that resulted, a special containment vessel with a highly efficient filtered exhaust was built. Utilizing this containment vessel, the release of beryllium particulates was minimized. A high efficiency filter was also placed on the room exhaust. It prevented releases of beryllium above AEC acceptable limits to the outside atmosphere. Author (NSA)

N68-19273*# North American Aviation, Inc., Los Angeles, Calif.
PROPULSION SYSTEM DYNAMIC SIMULATION THEORY AND EQUATIONS
Arnold W. Martin Washington NASA Mar. 1968 222 p refs
(Contract NAS2-3268)
(NASA-CR-928; NA-67-384) CFSTI: HC $3.00/MF $0.65 CSCL 14B

This report presents the theory, equations and assumptions for a propulsion system dynamic simulation program with emphasis on the air induction system. Although the simulation program was developed and used primarily for the XB-70, the theory and equations are sufficiently general to be applicable to a wide range of inlet configurations and flight conditions. Similarly, while the majority of simulation runs have utilized a digital computer in conjunction with the General Electric Company's "Dynasyar" program, the simulation is adaptable to other computing systems, and to analog computers. Author

N68-19373# Los Alamos Scientific Lab., N. Mex.
ON THE MEDIUM ENERGY PHYSICS PROGRAM Quarterly Status Report, Period Ending Jul. 31, 1967
14 Sep. 1967 43 p refs
(Contract W-7405-ENG-36)
(LA-3772-MS) CFSTI: HC $3.00/MF $0.65

The status of developments in accelerator structures, of power sources, accelerator control and instrumentation, accelerator physics, and project scheduling and facilities planning for the period ending July 31, 1967 is presented. NSA

N68-19410# Royal Aircraft Establishment, Farnborough (England).
LABORATORY SCALE DEVICES FOR RAIN EROSION SIMULATION
F. G. Hammit, J. F. Lafferty, R. Cheesewright, M. T. Pitek, D. J. Kemppainen et al *In its* Rain Erosion and Assoc. Phenomena Aug. 1967 p 166–190 refs (See N68-19401 09-13)

The use of various laboratory devices for the study of rain erosion phenomena are discussed. The relative merits of a facility utilizing a stationary drop of liquid and a moving target are compared to the alternative of accelerating a mass of liquid and permitting it to impinge on a stationary (or moving) target. It is demonstrated that water droplets of the size of typical raindrops cannot maintain their spherical shape under high acceleration and that the acceleration of droplets of this size to the velocities of interest is a major problem; however, the problems inherent in obtaining the relative velocities of interest by means of a moving target appear to be prohibitive for laboratory simulation of rain erosion. A single-impact laboratory device, for the study of the mechanism by which liquid impact damage occurs, is described and some preliminary results obtained with the facility are presented. Preliminary work with a multiple-impact device is described and evidence is presented to demonstrate the feasibility of using cavitation tests to provide a relative ranking of the erosion-resistance of materials. Author

N68-19412# Royal Aircraft Establishment, Farnborough (England).
SOME REMARKS ON SINGLE IMPACT STUDIES AT THE ROYAL AIRCRAFT ESTABLISHMENT
G. H. Kinner *In its* Rain Erosion and Assoc. Phenomena Aug. 1967 p 211–220 refs (See N68-19401 09-13)

A single-impact gun has been installed to provide a rapid means for studying the principle parameters known to influence the nature and extent of rain erosion damage. The system has the important feature that the droplet surface remains spherical up to the time of initial impact. A simple analytical treatment of experimental data has been adopted and based on the rate of propagation of the compression wave through the droplet and on the concept of dividing the droplet into imaginary columns with their axes parallel to the direction of attack. The extent of damage is intrinsically proportional to sin θ, where θ is the angle which the target surface makes to the direction of attack. Kinetic energy factors are introduced to explain the extent of the annular crater-type damage found on PMMA surfaces and the effect of change in velocity of impact. Author

12 FLUID MECHANICS

Includes boundary-layer flow; compressible flow; gas dynamics; hydrodynamics; and turbulence. For related information see also: 01 Aerodynamics; and 33 Thermodynamics and Combustion.

N68-18260# Hydronautics, Inc., Laurel, Md.
ANALYSES ON WAVES AND THE WAVE RESISTANCE DUE TO TRANSOM STERN SHIPS
B. Yim Nov. 1967 72 p refs
(Contract Nonr-3349(00))
(TR-117-11; AD-664503)

Waves and the wave resistance due to a ship with a transom stern are analyzed starting with an exact formulation of the general ship wave problem. Greens theorem is utilized together with the well known Greens function which satisfies the linear free surface boundary condition on the free surface. Then a linearization is attempted for two types of ships; thin ships and flat ships. A transom stern ship is represented by the combination of these two types of ships. For the analysis of transom stern ships, it is required to take at least the second order terms in the formal development. It is found that the immersed transom stern acts to cancel stern waves. Using a limited form of Michells wave resistance formula, the wave resistance of the transom stern ship is analyzed. Author (TAB)

N68-18278# Aerospace Research Labs., Wright-Patterson AFB, Ohio.
SOLUTION OF THE LAMINAR BOUNDARY-LAYER EQUATIONS WITH MASS TRANSFER BY THE GKD MULTIMOMENT METHOD Final Scientific Report
Howard E. Bethel Mar. 1967 101 p refs
(ARL-67-0045; AD-664591)

The Galerkin-Kantorovich-Dorodnitsyn multimoment method is applied to the solution of the steady, two dimensional and axially symmetric laminar boundary-layer equations for the limited class of compressible flows which admit transformation to a corresponding incompressible flow. The convergence and exactness properties of the approximate solutions are presented. The solutions converge toward the exact, usually in a uniform manner. The third and higher orders of approximation are in general less than one percent in error. The fourth order of approximation is suggested as the best compromise between the requirements of accuracy and computational feasibility. The method is applied to several trial calculations which span the spectrum of flows with mass transfer. The results for these flows are in substantial agreement with numerical solutions. The least accurate approximate results are found in the vicinity of blow off on a flat plate. Author (TAB)

N68-18326# General Precision, Inc., Little Falls, N. J. Aerospace Research Center.
VORTEX PHENOMENA STUDY CONTINUATION PROGRAM Final Report, May 1966–Oct. 1967
Edward L. Rakowsky, Lawrence S. Galowin, and Michael J. De Santis Dec. 1967 206 p refs
(Contract DA-01-021-AMC-11203(Z))
(GPSI-1590-6707; AD-664198)

The objective of the program was to obtain the detailed description of the flow field in a sink vortex-type device applicable

as a flueric angular rate sensor. Basically, the device consists of two coaxial surfaces with an outlet tube on the axis of symmetry. Radial inflow of the fluid develops a sink flow field with a vortex generated by an angular rate input through fluid coupling at the outer radii of the surfaces. Experimental and analytical studies were conducted of nonsteady flow (primarily impulsive) in the pancake region and of the flow field in the sink region. The study of the sink region was conducted to develop a rational basis for the design of the sink wall contour and to obtain a definition of the flow field in the sink region. Theoretical analyses of three sink contours were conducted; these were mechanically designed, fabricated and tested using hot-wire anemometry techniques to measure the velocity distributions and turbulence intensities. In addition, a computer program was developed for the numerical solution of the rotational Euler equations for general prescribed inlet conditions and axisymmetric boundary conditions. With this program, inviscid flow fields were computer for various boundary conditions. Correlation of these analytic results with the experimentally determined flow fields is summarized. Author (TAB)

N68-18327# Purdue Univ., Lafayette, Ind. Fluid Mechanics Group.

ON THE ANALYSIS OF THE TURBULENT BOUNDARY LAYER BY THE METHOD OF WEIGHTED RESIDUALS

George S. Deiwert and Douglas E. Abbott Nov. 1967 178 p refs

(Contract DA-31-124-ARO(D)-479)

(FMTR-67-2; AROD-6340.2-E; AD-664247)

The solution of the incompressible, turbulent boundary-layer equations using the method of weighted residuals is investigated. This method seeks to obtain an approximate solution of a partial differential equation with given boundary conditions by assuming the solution in functional form so that the boundary conditions for one variable are exactly satisfied. The approximating function is then specialized in such a manner as to obtain approximate satisfaction of the given equation. Author (TAB)

N68-18367# Oklahoma State Univ., Stillwater. Dept. of Chemistry.

MOLECULAR FLOW AND THE EFFUSION PROCESS IN THE MEASUREMENT OF VAPOR PRESSURES Final Report, 1 Sep. 1964–31 May 1967

Robert D. Freeman Wright-Patterson AFB, Ohio Res. and Technol. Div. Nov. 1967 92 p refs

(Contract AF 33(657)-8767)

(ASD-TDR-63-754, Pt. 3; AD-664069)

Extensions to conical orifices of Clausings analysis of angular distribution of molecules effusing from cylindrical orifices resulted in numerical values for transmission probabilities and recoil-force correction factors which are tabulated. With these results, it is demonstrated that the optimum orifice geometry for (1) recoil force measurements is a diverging conical orifice with semi-apex angle of 30 degrees, (2) delivery of maximum fraction of effusing molecules onto (or into) a target (aperture) is a long cylindrical orifice. Modifications to the angular distribution apparatus are described and experimental results given for four orifices and two gases over the pressure range 5 to 900 dyn/sq. cm. Additional results for experimental transmission probabilities of orifices determined by the Multicell technique are generally in agreement with theoretical values within 2 to 5%. The Miker technique for simultaneous determination of vapor pressure by rate of effusion and by recoil force measurements was refined to the point that recoil force data are as reproducible as rate of effusion measurements. A new furnace and a modified automatic control system for the microbalance are described. TAB

N68-18383# Hebrew Univ., Jerusalem (Israel). Dept. of Physics.

ELECTRON DENSITY AND IONIZATION PHENOMENA IN SHOCK WAVES Final Scientific Report, 1 Nov. 1964–31 Oct. 1967

W. Low 30 Nov. 1967 31 p refs

(Contract AF 61(052)-846)

(AFOSR-68-0230; AD-664588)

The microwave attenuation of the air of shock waves of well-developed shocks within Mach number 7-12 was measured. The time dependence of the microwave attenuation was also carefully studied. The effect of converging or diverging transition sections was investigated by measuring (a) Changes in the Mach speed (b) Changes in the microwave attenuation (c) Optical light emission. Author (TAB)

N68-18411# Air Force Systems Command, Wright-Patterson AFB, Ohio. Flight Dynamics Lab.

SIMILARITY OF NONEQUILIBRIUM AIR EXPANSIONS IN HYPERSONIC NOZZLES Technical Memorandum, Apr. 1966–Apr. 1967

Donald J. Harney May 1967 27 p refs

(FDM-TM-67-1; AD-664084) CFSTI: HC $3.00/MF $0.65

The entropy correlation for the nonequilibrium composition of air expanded in a hypersonic wind tunnel nozzle is extended to include the effect of nozzle geometry. A single set of curves based upon a similarity parameter allows the rapid estimation of the test section gas composition and the chemical energy frozen into the flow. TAB

N68-18444# Colorado State Univ., Fort Collins. Fluid Mechanics Program.

SIMULATION OF MOUNTAIN LEE WAVES IN A WIND TUNNEL

J. T. Lin and G. J. Binder Dec. 1967 133 p refs

(Grant DA-AMC-28-043-65-G20)

(CER67-68JTL-GJB24; AD-664172)

Mountain lee-waves were simulated in a wind tunnel where the density stratification was produced by heating the ambient air and cooling the lower boundary. The flow patterns were visualized with smoke and were also determined from mapping of the temperature fields measured point by point with thermocouples and platinum resistance thermometers. The magnitudes of the velocities were measured with a constant temperature hot-wire anemometer. Since this instrument is also temperature sensitive the compensation of this effect at very low velocities (the actual velocities were about 0.5 ft/sec) was experimentally determined. The flow was composed of two layers of which the lower one (thickness 7-8 in.) had the large stability. The Froude number was calculated on the basis of the height, stability and average velocity in the lower layer. Two bell-shaped model mountains of the same height (4 in.) but of different horizontal scales were used. This simulation experiment reproduced all the main features of mountain lee-waves, namely the wave profile, the rotor below the crest of the first wave, the strong velocity increase on the lee slope (1.5-1.8 times the average upstream velocity). Strong turbulence was found in the upper part of the rotor. The wave length at a fixed elevation of the lee-waves was found to increase linearly with Froude number; the amplitudes did also increase with Froude number. Author (TAB)

N68-18475# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ENERGY CALCULATION OF A SHOCK WAVE IN WATER [RASCHET ENERGII UDARNOY VOLNY V VODE]

L. P. Orlenko and L. P. Parshev 18 Aug. 1967 8 p refs Transl. into ENGLISH from Zh. Prik. Mekhan. Tekhn. Fiz. (Moscow), no. 5, 1965 p 130–131

(FTD-HT-66-574; AD-664536)

The energy of an underwater shock wave stemming from an underwater explosion is solved through consideration of

irreversible mechanical dissipation of energy. The dissipation of energy in an underwater shock wave is determined with the aid of the shock adiabatic, discharge isentropes, and the variation of frontal pressure with distance. The total value of irreversible energy loss in a shock wave from an underwater explosion with spherical throw-out of explosive material is given. TAB

N68-18480 IIT Research Inst., Chicago, Ill.
THE MIXING OF TWO PARALLEL STREAMS OF DISSIMILAR FLUIDS
Richard Le Roy Baker (Ph.D. Thesis) 1967 263 p
Available from Univ. Microfilms: HC $11.95/MF $3.40 Order No. 67-7023

Similarity solutions were obtained for laminar and turbulent mixing of two parallel streams. The solutions apply to both similar and dissimilar fluids in the two streams with any velocity or density ratio and arbitrary laminar or turbulent Schmidt numbers. Lessen's solution method for determining the hydrodynamic stability of the viscous flow in the mixing region for the homogeneous case was extended to apply to the heterogeneous case. Experimental data for two-dimensional free jet mixing of similar and dissimilar streams was obtained with a constant temperature hot-wire anemometer systems. The systems investigated were air-air, air-freon 12 and air-freon C318. The density ratios for these cases are 1, 1/4 and 1/7. The data included average velocity and turbulence intensity profiles for the homogeneous case and average velocity and average density profiles for the heterogeneous case. Only turbulent mixing was observed experimentally. Dissert. Abstr.

N68-18526 Stanford Univ., Calif.
THE INTERACTION OF A SHOCK WAVE WITH A LAMINAR BOUNDARY LAYER
Theodore Alison Reyhner (Ph.D. Thesis) 1967 188 p
Available from Univ. Microfilms: HC $8.60/MF $3.00 Order No. 67-7959

This work presents an approximate solution to the problem of the interaction between an impinging shock wave and a laminar boundary layer. It is shown that the use of the Prandtl boundary-layer equations does lead to a meaningful solution for this problem when the pressure gradient is determined by the assumption that the outer edge of the boundary layer is undergoing a Prandtl-Meyer compression. A Blasius flow along a flat plate that is disturbed by an impinging shock wave is considered. The solution is restricted by the use of the Prandtl–Meyer formula to weak shocks such that the flow at outer edge of the boundary layer is always supersonic. A method is developed for solving the nonlinear boundary-layer equations. The method works when the normal velocity from the boundary-layer equations is used in determining the pressure gradient. Finite-difference equations are employed, and iteration allows solving a nonlinear finite-difference approximation of the boundary-layer equations. Dissert. Abstr.

N68-18612# Von Karman Inst. for Fluid Dynamics, Rhode Saint-Genese (Belgium).
LAMINAR SEPARATION IN HYPERSONIC FLOWS Final Scientific Report, 1 Oct. 1966–30 Sep. 1967
Jean J. Ginoux 30 Nov. 1967 19 p refs
(Grant AF-EOAR-67-09)
(VKI-CR-67-GI-I-1; AFOSR-68-0231; AD-664602) CFSTI: HC $3.00/MF $0.65

An experimental investigation of the laminar flow over a cone-cavity model with a rounded reattachment shoulder at zero angle of attack was conducted at M = 5.4. For mass injection into the cavity at rates up to eight-tenths the boundary layer mass flow at separation, the pressure and heat transfer distributions along the surface were obtained, with emphasis on the reattachment zone. A simple empirical correlation was established between reattachment pressure and heat transfer peaks as a function of injection rate. Author (TAB)

N68-18644# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ON PLANE MOTION OF VESSEL WITH THE WIND [K PLOSKOMU DVIZHENIYU SUDNA PRI VETRE]
A. P. Vorob'yev *In its* Herald of Leningrad Univ., Math., Mech. and Astronomy Ser., No. 1, 1963 27 Apr. 1967 p 113–118 refs (See N68-18631 09-19)

Equations are formulated for the plane motion of a vessel, similar to the rectilinear motion. Account is taken of the chance strength of the wind acting on the vessel. Probability characteristics of speed, the angle drift and angular speed are determined. Author

N68-18645# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ON CERTAIN PECULIARITIES OF GAS MOTION AT HYPERSONIC SPEEDS [O NEKOTORYKH OSOBENNOSTYAKH DVIZHENIYA GAZA PRI GIPERZVUKOVYKH SKOROSTYAKH]
A. A. Grib, G. Baush, and L. M. Vyaz'menskaya *In its* Herald of Leningrad Univ., Math., Mech. and Astronomy Ser., No. 1, 1963 27 Apr. 1967 p 119–129 refs (See N68-18631 09-19)

A method is given for the approximate solution of the problem of hypersonic flow on bodies of rotation and flat contours with arbitrary dependence of the internal energy on pressure and temperature. It is assumed that the shock is not intensive. Some singularities, connected with the method of solution of the Mizes equations in the form of series of small parameter degrees, are found. Author

N68-18647# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
VIRTUAL MASSES OF AN ELLIPTIC CYLINDER DURING MOTION IN LIQUID, LIMITED BY A FLAT WALL OR A FREE SURFACE [PRISOYEDINENNYYE MASSY ELLIPTICHESKOGO TSI-LINDRA PRI DVIZHENII V ZHIDKOSTI, ORGRANICHENNOY PLOSKOY STENKOY ILI SVOBODNOY POVERKHNOST'YU]
V. A. Sabaneyev *In its* Herald of Leningrad Univ., Math., Mech. and Astronomy Ser., No. 1, 1963 27 Apr. 1968 p 141–151 refs (See N68-18631 09-19)

Consideration is given to the unsteady motion of an elliptical cylinder in an ideal incompressible fluid bounded by a plane wall or a free surface. Approximations of the velocity potentials for all cases where the major axis of the cross section keeps parallel to the wall all through the motion are given. The virtual masses are calculated with the approximate expressions. M.G.J.

N68-18650# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ON POSSIBILITY OF NUMERICAL SOLUTION OF LAMINAR BOUNDARY LAYER PROBLEM ON SEMI-INFINITE BODY WITH SUCTION IN DISSOCIATING GAS [O VOZMOZHNOSTI CHISLENNOGO RESHENIYA ZADACHI LAMINARNOGO POGRANICHNOGO SLOYA NA POLUBESKONECHNOM TELE S OTSOSOM V DISSOTSIIRUYUSHCHEM GAZE]
L. A. Kulonen *In its* Herald of Leningrad Univ., Math., Mech. and Astronomy Ser., No. 1, 1963 27 Apr. 1967 p 185–187 refs (See N68-18631 09-19)

A method of numerical solution of laminar boundary layer problem on the semi-infinite body with suction in dissociating gas far from the forward critical point is proposed. The solution near $x = \infty$ can be obtained by means of expansion of functions in series. The numerical method of lines can be applied to the construction of solution for every x, reducing the problem to the solving of usual differential equations. Author

N68-18663*# Southwest Research Inst., San Antonio, Tex. Dept. of Mechanical Sciences.

SIMULATED LOW-GRAVITY SLOSHING IN SPHERICAL TANKS AND CYLINDRICAL TANKS WITH INVERTED ELLIPSOIDAL BOTTOMS

Frank T. Dodge and Luis R. Garza Feb. 1968 42 p refs

(Contract NAS8-20290)

(NASA-CR-61583; TR-6) CFSTI: HC $3.00/MF $0.65 CSCL 20D

Liquid sloshing in cylindrical tanks having inverted ellipsoidal bottoms and in spherical tanks is studied experimentally under conditions of simulated low gravities. The effects of variable liquid depth and the determination of the smooth wall damping are emphasized. Results from cylindrical tanks are qualitatively similar to results obtained previously with cylindrical tanks having flat bottoms; significant differences from previous results for natural frequency and slosh damping are apparent, however, for small liquid depths. Correlation equations for the damping coefficient as a function of h/d, N_{GA}, and N_{BO} are presented. Results from spherical tanks show that the variation in free surface curvature with liquid depth has a strong effect on the natural frequency; in fact, increased curvature in spherical tanks are compared to cylindrical tanks causes the natural frequency to decrease as N_{BO} decreases, which is just the opposite of the variation obtained with cylindrical tanks. The damping in spherical tanks is shown to be a minimum when the tank is half-full. Author

N68-18670# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

TOWARD THE DETERMINATION OF LINEARIZED PERTURBATION FLOWS IN THE HYPERSONIC FLOW OVER CONICAL BODIES WITHOUT AXIAL SYMMETRY [K OPREDELENIYU LINEARIZOVANNYKH POTOKOV VOZMUSHCHENIY PRI GIPERZVUKOVOM OBTEKANII NEOSESIMMETRICHNYKH KONICHESKIKH TEL]

A. M. Mkhitaryan and M. P. Ovsyannikov *In its* News of Inst. of Higher Learning. Aeron. Eng. 10 Apr. 1967 p 7–15 refs (See N68-18668 09-23)

This paper presents a study of hypersonic flow over thick conical bodies without axial symmetry and constitutes a development of similar studies by Ferri, Ness, Kaplita, and Chapkis, using a linearized procedure. The equations that define the velocity components of the linearized flow fields are written and boundary conditions on the body surface and at shock wave which must be satisfied are established. Certain simplifying assumptions are introduced in the analysis. Two linearized solutions are obtained, and it is shown that at free-stream Mach numbers, the velocity components just behind the shock wave are of the same order for thick conical bodies. The calculated values of the pressure coefficients for thick elliptical cones, obtained by approximate formulas of the asymptotic solution and by a step-by-step numerical procedure, are given in graphical form for the purpose of comparison. Author

N68-18677# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

TURBULENT MIXING OF FLUID FLOWS IN A LIMITED SPACE WITH PECULIARITIES IN THE FEED OF ONE OF THE FLOWS [TURBULENTNOYE SMESHENNIYE POTOKOV ZHIDKOSTI V ORGANICHENNOM PROSTRANSTVE PRI OSOBENNOSTYAKH V PODVODE ODNOGO IZ POTOKOV]

A. P. Pudoveyev *In its* News of Inst. of Higher Learning. Aeron. Eng. 10 Apr. 1967 p 83–90 (See N68-18668 09-23)

The problem of the turbulent mixing of fluid streams in a confined space and the effect of the mixing on the structure and parameters of the resulting flow is studied theoretically. As a first approximation, the interaction between transverse streams of an incompressible fluid in a plane channel is considered. The specific characteristics considered are those of a uniform, finite-velocity stream of a fluid injected transversely into a second stream of the same fluid in a channel with a limited mixing zone. It is assumed that the densities of the interacting streams are the same; the pressure change across the mixing zone and the effect of the viscosity along the channel wall are negligible. Using the equations of continuity, momentum, and energy, an equation is derived for determining the boundaries of the mixing zone. Analytical and graphical solutions of the equation show that the boundary layer expands by the linear law and that the expansion intensity is determined by the ratio of the velocities of the two streams. Author

N68-18683# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ON THE PRESSURE COEFFICIENT AT HYPERSONIC VELOCITIES [O KOEFFITSIENTE DAVLENIYA PRI GIPERZVUKOVYKH SKOROSTYAKH]

S. V. Fal'kovich and N. G. Bol'man *In its* News of Inst. of Higher Learning. Aeron. Eng. 10 Apr. 1967 p 129–133 refs (See N68-18668 09-23)

The pressure coefficient for a wedge in a symmetric, hypersonic, ideal gas stream was calculated using an expansion technique in powers of sin θ, where θ is the wedge half angle. Author

N68-18731*# National Aeronautics and Space Administration, Washington, D. C.

EFFECT OF CURVED SURFACES ON TURBULENT BOUNDARY LAYERS [TURBULENTE GRENZSCHICHTEN AN GEWOELBTEN FLAECHEN]

H. Wilcken Dec. 1967 36 p refs Transl. into ENGLISH from GERMAN

(NASA-TT-F-11421) CFSTI: HC $3.00/MF $0.65 CSCL 20D

To clarify the influence of curvature upon turbulent boundary layers, a series of experiments were carried out in which the experimental equipment was arranged so that the secondary flows would be as small as possible. The inner and outer walls of a curve of rectangular cross section served as the curved surfaces, with the dimension of the curved surface considerably shorter in the radial direction than in height. The experiments were carried out in air, and the speeds used did not exceed 25 m/sec. The air was dealt with as an inelastic flow, since air compressibility makes itself felt only in the neighborhood of the speed of sound. In general, each series of experiments was carried out at three different speeds in order to determine the possible effect of the Reynolds factor. The results indicate that at concave surfaces the turbulence is very greatly increased, while at convex surfaces it is reduced. M.G.J.

N68-18774* North American Aviation, Inc., Downey, Calif. Space and Information Systems Div.

FLOW FIELD PREDICTION AND ANALYSIS STUDY FOR PROJECT RAM B3 Supplementary Report, Nov. 1965–Apr. 1966

W. H. Ball 27 Apr. 1966 62 p refs

(Contract NAS1-4743)

(NASA-CR-66573; SID-66-213) CFSTI: $3.00 CSCL 20D

This report presents the results of analytical studies conducted to predict the equilibrium electron density distribution about the RAM B3 vehicle for a series of fourteen flight conditions and to investigate the effects of small in-flight misalignments with the flight path for two typical flight conditions. The equilibrium flow fields were computed and body normal locations used in the nonequilibrium analyses reported. The equilibrium data were computed by a free-energy minimization program, using as input thermodynamic variables, the pressure and temperature data from the previously computed equilibrium flow fields. The study to investigate the effects of angle-of-attack misalignments during flight on nonequilibrium flow field properties was performed for two flight conditions selected from RAM B3 flight trajectory. The results of the equilibrium analyses are presented in the form of spatial distributions of electron density along body normals, with nonequilibrium electron concentration shown for comparison. The results of the

nonequilibrium angle-of-attack studies are presented as spatial plots of electron concentration, pressure, and temperature along body normals. Author

N68-18778*# Oklahoma State Univ., Stillwater. Fluid Power and Controls Lab.

STUDY OF FLUID TRANSIENTS IN CLOSED CONDUITS Interim Report

C. R. Gerlach (Ph.D. Thesis) 27 Jun. 1966 171 p refs

(Contract NAS8-11302)

(NASA-CR-61622; IR-65-4) CFSTI: HC $3.00/MF $0.65 CSCL 20D

The dynamics of viscous fluid transmission lines have been investigated with emphasis being placed upon topics of interest in both fluid systems engineering and acoustic fields. An exact solution of the first-order Navier–Stokes equation was obtained to describe the dynamics of a viscous, compressible liquid in closed conduits. Calculations were made of the spatial attenuation factor and phase velocity for several modes for both rigid and elastic flexible conduit walls. Also calculated were the velocity profiles near an oscillating piston and subsequently the state of shear stress near the piston. Engineering models, based upon approximations of the zeroth mode, were developed and experimental studies were made of the frequency response and transient response of a viscous fluid transmission line. Author

N68-18848*# Lockheed Missiles and Space Co., Sunnyvale, Calif.

ANALYTICAL AND EXPERIMENTAL STUDY OF LIQUID-ULLAGE COUPLING AND LOW GRAVITY INTERFACE STABILITY Final Report, 1 Jun. 1965–29 Aug. 1966

S. E. Hurd, M. P. Hollister, J. H. Chin, H. M. Satterlee, and E. Y. Harper 29 Aug. 1966 94 p refs

(Contract NAS8-11525)

(NASA-CR-61620; LMSC-2-05-66-1) CFSTI: HC $3.00/MF $0.65 CSCL 20D

A mathematical model, describing liquid-ullage coupling, was extended to include arbitrary pressurization with a noncondensible gas, bottom heating, and nucleate boiling in the boundary layer. In addition, the model considers transition from laminar to turbulent flow in the free-convection boundary layer, tank volume change due to tank strain, and arbitrary end-geometry for a cylindrical tank. Experiments were conducted to validate the model and to develop empirical correlations for three parameters: the vapor-side interface heat transfer coefficient, the liquid-side interface heat transfer coefficient, and the liquid energy integral. In general, predictions obtained from the model agreed well with the data. The methods used in analyzing the interface stability are reviewed, and details are given on the drop-tower experiments conducted to define the boundary-layer breakthrough problem. It was observed that free surface Weber numbers greater than 50 resulted in an unstable interface when the gravity level was reduced to zero. The stabilizing effect of a finite acceleration was evident, and very little distortion of the free surface shape occurred at a Froude number of 0.2. M.G.J.

N68-18997*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

RESULTS OF INCLUDING A BOUNDARY SHOCK WAVE IN THE CALCULATION OF THE FLIGHT PARAMETERS OF A LARGE HIGH-SPEED METEOR

E. Dale Martin Washington Mar. 1968 58 p refs

(NASA-TN-D-4325) CFSTI: HC $3.00/MF $0.65 CSCL 20D

The results of including a boundary shock wave in the calculation of the flight parameters of a large high speed meteor with rapid vapor ablation are investigated. Calculations for the meteor use a data curve fitted graphically to the meteor tracking data. These calculations indicate that the proper range of conditions was present on the meteor for a significant portion of its trajectory, for a very thin strong boundary shock to occur at the meteor surface in the vapor, according to the boundary shock wave theory. Accounting for the effects of the boundary shock wave decreases the pressure drag, but the viscous-compressive drag is high, so the effective drag coefficient is unchanged by the boundary shock. Detailed calculations of the flow about a large high speed meteor would be greatly affected by the boundary shock effects, but overall gross values of the heating and motion parameters calculated by methods used recently by H. J. Allen and N. A. James are valid because of their use of appropriate assumed values of certain parameters. Author

N68-19000*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

FORCES AND MOMENTS PRODUCED BY AIR AND HELIUM JETS EXHAUSTING PARALLEL TO A FLAT PLATE IN A NEAR VACUUM

Joseph J. Janos and Sherwood Hoffman Washington Mar. 1968 40 p refs

(NASA-TN-D-4408) CFSTI: HC $3.00/MF $0.65 CSCL 20D

An investigation was conducted in the 41 foot vacuum sphere to determine the impingement forces, moments, and centers of pressure on a flat plate produced by small control type nozzles or jets discharging generally parallel to the plate in a near vacuum. The nozzles tested were conical, had approximately the same throat areas, utilized unheated gas, and had nominal exit Mach numbers of 1, 3, 5, and 7 for air, and 1, 3, and 7 for helium. The ratios of nozzle total pressure to ambient pressure varied from 15×10^6 to about 22×10^6; the ratios of nozzle exit pressure to ambient pressure varied from about 1.4×10^4 to 12×10^6 for the tests at a constant pressure altitude of 95 kilometers. Nozzle positions were varied longitudinally and vertically relative to the plate. Angle of incidence of the flat plate relative to the nozzle center line was varied between $-2°$ and $10°$ for the air nozzles. The flat plate was detached from the nozzle and mounted on a balance to measure the impingement effects directly. Significant normal forces and moments were obtained and were found to be dependent on nozzle vertical position, longitudinal position, jet exit Mach number, jet flow turning angle, and angle of incidence of the plate. The largest normal force was equal to about 50% of the gross thrust of the Mach number 1 nozzle when located relatively close to the plate. The impingement forces decreased with increasing height or jet Mach number, and decreasing jet turning angle or angle of plate incidence. Helium jets produced lower impingement forces and moments than the corresponding air jets at comparable locations. Author

N68-19002# Argonne National Lab., Ill. Reactor Engineering Div.

EXPULSION OF LIQUID FROM A RAPIDLY HEATED CHANNEL

Ralph M. Singer May 1967 66 p refs

(Contract W-31-109-ENG-38)

(ANL-7337) CFSTI: HC $3.00/MF $0.65

To determine the dynamic behavior of a partially confined liquid in contact with a rapidly heated surface, experiments were conducted using water, methanol, ethylene bromide, and acetone. The inner wall of an annulus was rapidly heated by a rectangular power pulse; the pressure, temperature, and motion of the fluid in the annulus were measured. The wall was heated at rates up to about 1.4×10^4°C/sec, the liquids were subcooled from 0 to 110°C, the liquid head varied from 0 to 1.5 m above the heated section, the annular spacing was either 1.27 or 3.18 mm, the initial liquid velocity varied from 0 to 9 m/sec, and the initial system pressure was always 1 atm. Transient pressures up to about 18 atm and expulsion velocities up to about 16 m/sec were measured. Only slightly subcooled liquids could be expelled, although the largest pressures were generated when the liquid was highly subcooled. The results of over 400 experiments are summarized. Author (NSA)

N68-19003# Israel Inst. of Tech., Haifa. Dept. of Aeronautical Engineering.

STABILITY OF ONE-DIMENSIONAL COMPRESSIBLE FLOWS

E. Wasserstrom Sep. 1967 24 p refs

(TAE-74) CFSTI: HC $3.00/MF $0.65

The stability of one dimensional, cartesian, compressible, constant-entropy flows without shocks was studied. Necessary and sufficient conditions for stability are found and it is concluded that flow regions in which the fluid particles undergo compression are unstable. The flow is defined as locally and instantaneously stable if small perturbations decrease immediately after they are applied. Author

N68-19026*# Aztec School of Languages, Inc., Acton, Mass. Research Translation Div.

TURBULENT BOUNDARY LAYER OF A DISSOCIATED GAS AT THE INLET SECTION OF A TUBE [TURBULENTNYY POGRANICHNYY SLOY DISSOTSIIROVANNOGO GAZA V NACHAL'NOM UCHASTKYE TRUBY]

A. N. Leont'ev, B. P. Mironov, and A. V. Fafurin Washington NASA Mar. 1968 11 p refs Transl. into ENGLISH from Zh. Prikl. Mekhan. i Tekhn. Fiz. (Moscow), no. 8, 1967 p 100–105

(Contract NASw-1692)

(NASA-TT-F-11254) CFSTI: HC $3.00/MF $0.65 CSCL 20D

A previous solution to the development of a turbulent boundary layer of a gas under nonisothermal conditions has been extended to include the flow of a high-enthalpy gas (in which case it is necessary to consider the effect of the dissociation of the gas on the characteristics of the turbulent boundary layer). The analysis is developed for a mixture of several gases in frozen state inside the boundary layer and in equilibrium state at its boundaries. Formulas are derived for the friction and heat-transfer laws. A solution is obtained to the turbulent boundary-layer equations for the inlet section of the tube on the assumption of a constant wall temperature and subsonic velocities of the gas flow. Author

N68-19072# Ohio State Univ. Research Foundation, Columbus.

KNUDSEN AND MOLECULAR DIFFUSION OF GASES IN CAPILLARIES AND POROUS SOLIDS OVER LARGE PRESSURE RANGES Technical Progress Report, 1 Apr. 1967–31 Mar. 1968

Christie J. Geankoplis 22 Nov. 1967 16 p refs

(Contract AT(11-1)-1675)

(COO-1675-4) CFSTI: HC $3.00/MF $0.65

The diffusion of gases in small, straight capillaries or in porous media in the range of very low to high pressures is important in diffusion in porous catalysts, separation of gases in porous barriers, and diffusion in capillaries or other types of equipment. Few theories and models are available for predicting this diffusion at constant total pressure in these cases. The effects of many variables, as pressure, pore geometry, and the number of individual gases present, are still uncertain. Previous experimental data in the literature covered only a 50/1 range of pressures in porous solids, which did not cover the entire three-mechanism range of Knudsen, transition, and molecular diffusion. Most of the diffusion in industrial catalysts at one atmosphere pressure is in the transition region. Experimental data were obtained for diffusion of binary gases in different synthetic porous structures. One solid contained one micropore size and many macropore sizes, while another contained one macropore and two micropores. Theoretical equations were derived for these cases using a modified random pore model and the experimental data checked the predicted data. The data covered a 1300/1 pressure range which included the Knudsen and most of the transition region. A high pressure apparatus has been designed and is being constructed to extend the range of pressures to 345,000/1 which will allow all three regions to be studied. A method has been devised to make a plug containing 100 straight capillaries in parallel. Preliminary experiments are being carried out to test the theoretical capillary equation. A solution to the differential equations for diffusion of a three-component gas mixture was obtained for the complete transition region in an open system. The equations indicate that a maximum or minimum can occur in the concentration plot and that under certain conditions a diffusion barrier can exist. Author (NSA)

N68-19112# Joint Publications Research Service, Washington, D. C.

AEROPHYSICAL STUDIES OF SUPERSONIC FLOWS

8 Mar. 1968 175 p refs Transl. into ENGLISH from the book "Aerofizicheskiye Issledovaniya Sverkhzvukovykh Techeniy" Moscow–Leningrad, Nauka Publishing House, 1967 p 7–13, 66–73, 105–113, 128–178, 198–218, 227–233, 256–264, 270–283

(JPRS-44615) CFSTI: HC $3.00/MF $0.65

A series of articles on shock tube and aeroballistic research are presented. The research deals with flow formation around a model in a shock tube, measuring gas density behind a shock wave by the electron beam method, measuring the emittance and absorptivity of a gas behind a shock wave front, effects of variable heat capacity of a gas in supersonic flow around blunt bodies, the effect of both oscillatory and dissociative relaxation on supersonic flow around blunt bodies, a pressurized ballistic unit, a firing range for aerodynamic research, principles of constructing ballistic telemetry systems, design calculations for a lightweight gas gun with a lightweight piston, high speed flash photography, the shape of a trailing shock wave formed during supersonic motion of a hemisphere and a cylindrical plate in various gases, supersonic nonstationary flow around a model occurring at the interface of gases with different densities, and the loss of mass of low melting models in a ballistic unit. R.N.A.

N68-19190*# Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

RECENT STUDIES OF NONEQUILIBRIUM FLOWS AT THE CORNELL AERONAUTICAL LABORATORY

J. Gordon Hall and Anthony L. Russo 12 Apr. 1966 52 p refs Presented at 7th AGARD Colloq. on Recent Advan. in Aerothermochem., Oslo, 16–20 May 1966

(Contract NASr-109)

(NASA-CR-74170) CFSTI: HC $3.00/MF $0.65 CSCL 20D

Vibrational relaxation in supersonic nozzle, diatomic gas flow, is briefly reviewed. Initial line-reversal temperature measurements for N_2 nozzle flows are discussed, and confirmatory studies are described. The results of different investigators for air as well as N_2 are correlated, and line-reversal temperature data are presented for nozzle expansion in CO which shows fast vibration relaxation similar to N_2 expansions. Nonequilibrium effects in high enthalpy airflows over thick, wedge-flate plate bodies with strong flow expansion at the wedge plate corner are also briefly reviewed. Shock tunnel experiments and complementary nonequilibrium flow analyses are described which indicate substantial nonequilibrium effects on the flat plate surface pressures. The third problem reviewed concerns a time-dependent method for calculating inviscid nonequilibrium flow fields about an Apollo-type reentry body at arbitrary angle of attack. Application of the ideal gas solution from this method to an estimation of nonequilibrium ionization in the Apollo plasma sheath is discussed. Typical results are described for electron density distribution and consequent electromagnetic signal attenuation. E.J.S.

N68-19196 North Carolina State Coll., Raleigh.

STUDY OF VORTEX MOTIONS IN WAKE FLOWS

Paul Harrawood (Ph.D. Thesis) 1967 105 p

Available from Univ. Microfilms: HC $5.20/MF $3.00 Order No. 67-7415

Periodic vortex shedding behind a flat plate set normal to the flow is investigated experimentally in a water channel. A survey of some of the more notable theoretical and experimental researches on this problem is presented. A quantitative study of the periodicity of the eddy motion in the wake of the plate and a qualitative visual and photographic study of this motion by means of dye streaks are made, giving special attention to the effect of channel constriction. Oscillograph records attest to the precise periodicity of the eddy formations. The Strouhal number is shown to depend very strongly on the constriction ratio and to a lesser degree on the Reynolds number. An empirical equation relating Strouhal number, Reynolds number and constriction ratio is presented. Dissert. Abstr.

N68-19205*# Toronto Univ. (Ontario). Inst. for Aerospace Studies.
PROGRESS IN DEVELOPING HIGH ENERGY NOZZLE BEAMS
J. B. French and G. E. McMichael [1966] 13 p refs Presented at the 5th Intern. Rarefied Gas Dyn. Symp., Oxford, Jul. 1966
(Grant NsG-367)
(NASA-CR-77847) CFSTI: HC $3.00/MF $0.65 CSCL 20D

Some exploratory studies utilizing the electron beam to investigate the phenomena of the skimmer influence on nozzle beam formation are presented. The results suggest that the dominant region producing observed beam scattering is inside the skimmer. Photographs of the density field around a pre-skimmer and skimmer are also included. Author

N68-19225*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXPERIMENTAL INVESTIGATION OF VAPOR INGESTION IN THE CENTAUR LIQUID HYDROGEN TANK
Raymond F. Lacovic and Andrew J. Stofan Washington Mar. 1968 16 p refs
(NASA-TM-X-1482) CFSTI: HC $3.00/MF $0.65 CSCL 20D

An investigation of vapor ingestion during liquid outflow was conducted in a 1/3.67 and 1/38 scale-model Centaur liquid hydrogen tank at the Lewis Research Center. The purpose of the investigation was to establish the height above the concave oblate ellipsoidal tank bottom at which vapor ingestion would occur for two tank outflow rates at various acceleration levels in order to define Centaur propellant residuals. Experimental values of the liquid height at which vapor ingestion occurs were obtained at normal gavity. A Froude number simulation was then used to relate the normal gravity experimental data to other acceleration levels. The experimental values were correlated with an analytical expression based on Bernoulli's equations. The analytical expression correlated well with the experimental values over the entire range of tank outflow rates. Author

N68-19246*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
SIMILARITY SOLUTION FOR TURBULENT MIXING BETWEEN A JET AND A FASTER MOVING COAXIAL STREAM
Leo F. Donovan Washington Mar. 1968 27 p refs
(NASA-TN-D-4441) CFSTI: HC $3.00/MF $0.65 CSCL 20D

An analysis of turbulent mixing of a jet with a faster moving coaxial stream is presented, and a similarity solution is obtained for large initial ratios of coaxial-stream velocity to jet velocity. The analysis is compared with experimental data, and the velocity profiles at different axial positions are shown to be similar. Centerline velocities follow the predicted behavior reasonably well except for the smallest experimental velocity ratio; half-radii, an indication of the amount of jet spreading, vary as expected after a certain axial distance. The shear-stress distributions are not similar, even at the largest axial positions for which data are available. In addition, the similarity solution is extended to include constant-density mass transfer or heat transfer. Author

N68-19251 IIT Research Inst., Chicago, Ill.
EXPERIMENTAL STUDY OF THE FLOW FIELD IN AN IMPINGING JET
Ik Young Yun (Ph.D. Thesis) 1967 135 p
Available from Univ. Microfilms: HC $6.40/MF $3.00 Order No. 67-6969

The present study investigated flow-characteristics of a circular air jet impinging normally on a large plane surface using hot-wire anemometry. Mean velocity and turbulent intensity were measured in the entire flow field of the short impinging jet where the nozzle-to-plate distance is 1.2 nozzle diameters. Also measured were the spread of mixing zone into potential flow region and the growth of the boundary layer developed radially outward along the impingement plate. The measurements were extended to the flow-field of the long impinging jet with the nozzle-to-plate distances of 3.0 to 6.0 nozzle diameters. The influence of the nozzle-to-plate distance on the mean velocity and turbulence intensity distributions was then discussed. Dissert. Abstr.

N68-19257 IIT Research Inst., Chicago, Ill.
RAREFIED GAS DYNAMICS BETWEEN PARALLEL PLATES AND IN PIPES
Cecil John Marek (Ph.D. Thesis) 1967 141 p
Available from Univ. Microfilms: HC $6.80/MF $3.00 Order No. 67-7025

A unified treatment was presented of the flow and heat transfer behavior of gases in three regimes of flow--continuum, transition, and free molecular. The effect of the decrease in intermolecular collisions in the transition regime was theoretically taken into account. The gas stream was treated from a molecular approach using a two-stream Maxwellian velocity distribution and Maxwell's equations of transfer. The relationship between Maxwell's equations of transfer and the continuum properties was shown. A method was described for accurately determining the accommodation coefficient from experimental data of heat transfer between parallel plates at pressures in the transition regime. An analysis was made of Lokay's data for heat transfer between parallel plates in the transition regime, and from this the values of the accommodation coefficient were found to be 0.833 for air, approximately 1.0 for argon, and 0.393 for helium. The accommodation coefficient for hydrogen was found to decrease with an increase in surface concentration and to vary from 0.437 to 30 microns to 0.333 at one atmosphere. Pressure drop and heat transfer measurements were taken for nitrogen flowing in a one inch ID stainless steel tube at pressures in the transition regime. Accommodation coefficients could not be determined from these measurements due to limiting factors in the experimental procedure. Dissert. Abstr.

N68-19340*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
MODEL FOR FREQUENCY RESPONSE OF A FORCED FLOW, HOLLOW, SINGLE-TUBE BOILER
Eugene A. Krejsa Washington Mar. 1968 29 p refs
(NASA-TM-X-1528) CFSTI: HC $3.00/MF $0.65 CSCL 20D

A simple model is given for the frequency response of boiler inlet pressure to inlet flow. The boiler analyzed is a forced flow, single tube, shell and tube boiler with no inserts. The model yields a simple description of the boiler dynamic characteristics. The characteristics included in the model are boiler pressure drop, time required for the liquid temperature to reach saturation temperature, inertia of the liquid in the subcooled region, and mass storage due to the movement of the boundary between the subcooled and two-phase regions. The model is compared with experimental boiler frequency response data. The boiling fluid was Freon-113, which was heated by counterflowing hot water. The boiler exit quality ranged from 12 to 63 percent. Good agreement between the model and the data was obtained for qualities ranging from 23 to 63 percent. Author

N68-19441 British Hydromechanics Research Association, Cranfield (England).
REFERENCES ON INDUCERS FOR ROTODYNAMIC PUMPS
A. L. King Sep. 1967 22 p refs
(BIB-24) CFSTI: $3.00

An annotated bibliography is presented on inducers for rotodynamic pumps. Some references on disk-friction pumps are also included. R.N.A.

N68-19473 IIT Research Inst., Chicago, Ill.
MASS AND MOMENTUM TRANSPORT PROPERTIES IN ISOENERGETIC COAXIAL FLOWS
Louis Ira Boehman (Ph.D. Thesis) 1967 103 p
Available from Univ. Microfilms: HC $5.20/MF $3.00 Order No. 67-6966

The results of momentum and mass transfer investigations in the coaxial mixing of turbulent isoenergetic air streams are presented. From experimentally determined velocity and tracer gas concentration profiles, values of eddy viscosity and turbulent diffusion coefficients are calculated for the near jet region extending 25 jet diameters downstream of the jet orifice. These calculations are based, in part, on new expressions that were developed to yield reliable values in regions of the mixing region when existing expressions become indeterminate. An analysis of the governing equations and boundary conditions in which empirical equations were used to describe the velocity field, yielded expressions which describe the spreading of the mixing boundary and the axial as well as the radial variation of eddy kinematic viscosity in the fully developed mixing region. Special consideration is given to the case where the two streams have equal velocities. Dissert. Abstr.

13 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; oceanography; cartography; and geodesy. For related information see also: 20 Meteorology; 29 Space Radiation; and 30 Space Sciences.

N68-18295# Utah Univ., Salt Lake City. Upper Air Research Lab.
ROCKET INSTRUMENTATION FOR THE GYRO-INTERACTION EXPERIMENT AEROBEE AE 3.614
Charles L. Alley, David A. Burt, Ralph Haycock, and Glenn D. Allred Oct. 1967 81 p refs
(Contract AF 19(628)-5044)
(UU-67-8; SR-4; AFCRL-67-0584; AD-664343)

A strong interaction between radio waves and the ionosphere when excited in the vicinity of the electron gyrofrequency has been denoted as gyro-interaction. If the radio wave is of sufficient strength, increased energy and collisions cause noticeable heating and increased electron density. To produce such a disturbance and provide a means of measuring the associated parameters, an Aerobee rocket (AE 3.614) was instrumented and flown from the Eglin Gulf Test Center, Florida. The report details the instrumentation used to produce gyro-interaction and measure its effects in the surrounding D-region of the ionosphere. Author (TAB)

N68-18312# Agricultural Research Service, Ithaca, N. Y. Soil and Water Conservation Research Div.
THE ENERGY BUDGET AT THE EARTH'S SURFACE: ORIGINS OF SHORT-TIME CO_2 FLUCTUATIONS IN A CORNFIELD Interim Report
E. R. Lemon, James L. Wright, and George M. Drake Jul. 1967 72 p refs Prepared in cooperation with Cornell Univ.
(Cross Service Order 2-68)
(ECOM-2-68I-2; RR-399; AD-664220)

Studies of the vertical distributions of CO2 fluctuation in a cornfield were made in the 4 to 0.25 cycle/minute frequency range. Amplitude of fluctuations decreased with height above the ground. Frequency in this range appeared rather constant, however. Sources and sinks for CO2 within the cornfield contribute in part to the fluctuations. However, eddy structure originating inside and/or outside the cornfield plays an important role too. Author (TAB)

N68-18325# Utah Univ., Salt Lake City. Upper Air Research Lab.
A PROPAGATION EXPERIMENT FOR MEASURING ELECTRON DENSITY IN THE D-REGION OF THE IONOSPHERE Interim Scientific Report
Clay D. Westlund and Craig Littlefield Sep. 1967 54 p refs Sponsored in part by DASA
(Contract AF 19(628)-5044)
(UU-67-7; AFCRL-67-0536; SR-3; AD-664577)

Determination of the profile of electron density versus altitude for the D-region of the ionosphere is made difficult because of the large ratio of neutral particles to charged particles. Experimental techniques which have been useful in the higher regions have not proven suitable for use in the D-region. This report describes a propagation experiment which can provide measurements related to electron density versus altitude. The experiment requires that two, harmonically-related frequencies be transmitted from a rocket as the rocket travels through the D-region. Each signal is separated into ordinary and extraordinary waves by the gyrotropic medium, and each of the components is influenced differently as it propagates through the medium. When the signals are received on the ground, the various modes are identical and measurements are made of relative Doppler shift and of relative absorption which occurred in transit. The theory of the experiment is briefly outlined and the experimental system is described. Author (TAB)

N68-18356# Johns Hopkins Univ., Baltimore, Md. Lab. of Physics and Physical Meteorology.
INFRARED OBSERVATIONS OF THE OUTER SOLAR CORONA Final Report, 1 Nov. 1964–31 Oct. 1967
Robert M. MacQueen 31 Oct. 1967 88 p refs
(Contract AF 49(638)-1432)
(AFOSR-67-2038; AD-664079) CFSTI: HC $3.00/MF $0.65

The 2.2 microns wavelength outer solar corona has been observed in two experiments: first, employing a ground-based telescope during the 93 second totality of the eclipse of 12 November 1966; and second, employing a balloon package with an infrared coronagraph, flown to an altitude of 28 km, during a 5.25 hour period, on 9 January 1967. The design and evaluation of the balloon-borne coronagraph is discussed, and the various origins of stray light investigated. The flight coronagraph was found to introduce a stray radiance of less than 3 x 10 to the -12th power B sub dot, where B sub dot is the radiance of the mean solar disk at 2.2 microns. During eclipse the corona was observed from 2 to 6 solar radii in the ecliptic plane, and at a single point perpendicular to the ecliptic, at 5 solar radii. Balloon observations covered the range 3.7 to 10 solar radii, at position angles from 20 degrees north to 40 degrees south of the ecliptic, on the east limb of the sun. Features attributed to the vaporization of interplanetary material were observed at 3.5, 4, 8.7 and 9.2 solar radii, the former two during the period of totality, and the latter three during the balloon observations. Author (TAB)

N68-18363# General Atronics Corp., Philadelphia, Pa.
LARGE APERTURE SEISMIC ARRAYS (LASA)
Bedford, Mass. AFSC, Electron. Systems Div. Dec. 1967 106 p refs
(Contract F19628-67-C-0370; ARPA Order 800)
(ESD-TR-67-630; QTR-2; AD-664571) CFSTI: HC $3.00/MF $0.65

Four topics are discussed in the progress report. The first topic is related to the masking of underground nuclear tests with large earthquakes. Computer simulations, using signals from actual seismic events, suggest that test detonations one magnitude unit smaller than the earthquake can be detected, providing the shot time is some two minutes after the time of occurrence of the earthquake. The second topic deals with the effects of signal-to-noise ratio and local travel time-anomalies on the accuracy of epicenter location using large seismic arrays. Both theoretical analyses and computer simulations indicate standard deviations of angular errors on the order of 0.3 degrees for either a 10 dB signal-to-noise ratio or a peak anomaly on the order of 1/20th of a second. The third topic deals with the application of a previously developed coda-correlation discriminant to DIMUS (hardlimited) seismograms. This discriminant makes use of the average paired correlation coefficient of the 10-second portion of seismic arrivals commencing 3 seconds after P-wave onset for an array of widely separated stations. Results to date indicate a moderate degradation of the discriminant for the DIMUS seismograms compared to the unclipped seismograms. The fourth topic deals with the automatic identification of the pP phase of earthquakes, for events in the 40 to 150 km depth region. Excellent results have been obtained with this automatic scheme, and not only is the pP phase properly identified, but also the sP phase. This combination allows depths to be estimated with considerable confidence. Author (TAB)

N68-18371# Aerospace Corp., El Segundo, Calif. Space Physics Lab.
ANALYTIC SOLUTIONS OF THE HEAT CONDUCTION EQUATION IN THE THERMOSPHERE, JUNE 1966–AUGUST 1967
Gary E. Thomas Nov. 1967 106 p refs
(Contract F04695-67-C-0158)
(TR-0158(3260-10)-3; SAMSO-TR-67-118; AD-664547) CFSTI: HC $3.00/MF $0.65

It is shown that the approximate one-dimensional equations of conservation of mass, momentum, and energy in the thermosphere, when expressed in an isobaric frame, have simple analytic Greens function solutions. Errors in the hydrostatic assumption are shown to be remarkably small, even for major temperature changes occurring over tens of minutes. Nonlinear error terms are estimated to be 10 percent in the temperature. The forms of the solutions depend upon the existence of a fixed-temperature lower boundary. It is suggested that this boundary should be identified with the level at which turbulence ceases (the turbopause). The usual concept of conduction-cooling time depends strongly upon the type of heating and may lead to a gross underestimate of the time required to reach a steady state. Comparison of the daily variation of temperature calculated on the basis of photoionization heating with results using more accurate numerical methods demonstrates the usefulness of the simple analytic approach. Author (TAB)

N68-18432# Naval Research Lab., Washington, D. C.
ATMOSPHERIC ELECTRIC CHARACTERISTICS OF REGIONS
J. H. Kraakevik and W. A. Hoppel 26 Dec. 1967 21 p refs
(NRL-6652; AD-664480)

Measurements of both polar conductivities, the electric field, mobility, density of small ions, and other related atmospheric variables were made from an airplane between 30 m and 6 km on two different series of flights separated by six years. Twenty-two soundings made in 1955-56 show that the general electrical characteristics can be classified by geographical regions. The variation of conductivity with altitude in the Arctic is shown to agree well with theory, if the value of mobility obtained in a 1962 series is used. A comparison of the two series indicates that the conductivity above the exchange layer and the mechanism by which the atmospheric potential is maintained was nearly the same, on the average, during both series of measurements. Author (TAB)

N68-18486*# Lockheed-California Co., Burbank.
MATHEMATICAL WIND PROFILES
Arnold Court, Robert R. Read, and Gerald E. Abrahams Feb. 1968 34 p refs
(Contract NAS8-5380)
(NASA-CR-61195) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Augmented Fourier polynomials, in which constant and linear terms have been added to a complex Fourier series, appear to offer a means for representing the vertical profile of the horizontal wind velocity. Reasons for selecting this function, and methods of its computation and application, are given. Polynomial coefficients are presented for mean monthly winds over Cape Kennedy, Florida, and for four consecutive soundings over Montgomery, Alabama. Author

N68-18487# Aeronautical Chart and Information Center, St. Louis, Mo. Linguistic Section.
DETERMINATION OF THE FIGURE OF THE EARTH FROM THE ANOMALIES OF THE VERTICAL GRAVITY GRADIENT [VYZNACHENNYA FIGURY ZA ANOMALIYAMYAMY VERTYKAL'NOGO GRADIENTASYLY TYAZHINNYA]
I. F. Monin Nov. 1967 12 p refs Transl. into ENGLISH from Dopovidi Akad. Nauk Uk. RSR (Kiev), Ser. B, no. 1, 1967 p 47–52
(ACIC-TC-1250; AD-664094) CFSTI: HC $3.00/MF $0.65

A solution of the problem concerning the determination of the figure of the earths topographic surface from the anomalies of the vertical gravity gradient was first presented in the Interdepartmental Republican Scientific Symposium Geodesy, Cartography, Aerial Photographic Survey. Publishing House of Lvov University, issue 4, 15 (1966). The present paper is a translation of another solution to this problem. Author (TAB)

N68-18491# Aeronautical Chart and Information Center, St. Louis, Mo. Linguistic Section.
RESULTS OF AEROMAGNETIC RESEARCH ALONG DEEP SEISMIC SOUNDING PROFILES [REZUL'TATY AEROMAGNITNYKH ISSLEDOVANIY PO PROFILYAM GSZ]
B. A. Matushkin Nov. 1967 14 p refs Transl. into ENGLISH from Sov. Geol. (Moscow), no. 1, 1967 p 131–135
(ACIC-TC-1254; AD-664095) CFSTI: HC $3.00/MF $0.65

This article is a translation of results of aeromagnetic research along deep sounding profiles in Central Asia, Caucasus and adjacent areas. The magnetic field was measured at the elevations of 500, 1500, 4000 and 9000 m from the sea level. The normal field obtained from the maps compiled by the Institute for Terrestrial Magnetism under Academy of Sciences of the USSR for the 1950 epoch was accepted as zero in the construction of graph. Author (TAB)

N68-18511# Harvard Univ., Cambridge, Mass. Lab. for Computer Graphics.
THE CONTINENT PROBLEM—GEOGRAPHY AND SPATIAL VARIANCE Interim Report
Christopher W. Warntz (Pa. Univ.) 22 Jan. 1968 31 p *Its* Paper No. 9
(Contract N00014-67-A-0298-0004)
(TR-9; AD-664511)

Let the earths surface be regarded as consisting of sets of two kinds of places, land and not-land. In terms of the analysis of variance applied to spatial distributions, how may the fragmented distribution of land over the earths surface be regarded as grouped into continents, each a separate source of spatial variance. Various variance ratios are investigated in this paper. A first approximation to a rigorous and defensible definition of continents based on spatial considerations alone is given and a more refined method is outlined. Author (TAB)

N68-18694# Illinois Univ., Urbana.
MONO VERSUS STEREO ANALYTICAL PHOTOGRAMMETRY Final Technical Report, 28 Sep. 1965–27 Sep. 1966
H. M. Karara 1 Feb. 1967 21 p refs *Its* Civil Engr. Studies Photogrammetry Ser. No. 9
(Contract DA-44-009-AMC-1338(X))
(AD-664184)

The precision of point transfer in the monocular and the stereoscopic approaches in analytical photogrammetry is compared. Basically, the problem is the elimination of y-parallax, whether in the point transfer device during dual transfer, or in the stereocomparator during measurement. The results seem to indicate that the precision of the monocular approach is significantly lower than that of the stereoscopic approach. This loss of accuracy is mainly due to the point marking system in the point transfer device used. Author (TAB)

N68-18711# Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science.
CERENKOV LIGHT EXPERIMENT—BOLIVIAN AIR SHOWER JOINT EXPERIMENT Final Technical Report
H. V. Bradt and A. S. Krieger Jan. 1968 9 p refs
(Grant AF-AFOSR-546-65)
(AFOSR-68-0179; AD-664355)

The report contains a description of the atmospheric cerenkov light detectors on MT. Chacaltaya, Bolivia. The experimental considerations governing the design of the apparatus are discussed and the experimental equipment is described. Author (TAB)

N68-18718# Ohio State Univ., Columbus.
A SOLUTION TO THE INVERSE PROBLEM FOR NEARLY-ANTIPODAL POINTS ON THE EQUATOR OF THE ELLIPSOID OF REVOLUTION Final Report
George Thien (M.S. Thesis) May 1967 52 p refs
(AD-664299)

The problem of determining the route of the geodesic between equatorial, nearly antipodal points on the ellipsoid of revolution has been apparent to geodesists for some time. It is evident that for two points on the equator which are 180 degrees apart, the distance between them is less when measured along the meridian route than measured along the equator. The route of the geodesic between these points is, therefore, trans-polar. On the other hand, when the longitudinal separation of equatorial points is somewhat less than 180 degrees, the geodesic between them follows the equator. As a result, the azimuth of the geodesic changes from ninety degrees to zero degrees as the longitudinal separation of its end points increases to 180 degrees. The description of this change in azimuth is fundamental to the determination of the route of the geodesic. Author (TAB)

N68-18763*# Ohio State Univ. Research Foundation, Columbus.
LEAST SQUARES ADJUSTMENT OF SATELLITE OBSERVATIONS FOR SIMULTANEOUS DIRECTIONS OR RANGES. PART 1: FORMULATION OF EQUATIONS
Edward J. Krakiwsky and Allen J. Pope Sep. 1967 95 p refs
(Contract NSR-36-008-033)
(NASA-CR-93425; Rept.-86, Pt. 1) CFSTI: HC $3.00/MF $0.65 CSCL 08E

The purpose of the report is to formulate the equations of the rigorous least squares adjustment of satellite observations for simultaneous directions or ranges. These equations are necessary for the programming of the adjustment system on a computer. Author

N68-18821*# Aztec School of Languages, Inc., Acton, Mass.
DETERMINATION OF PARAMETERS OF NOCTILUCENT CLOUDS SURVEYED IN 1964 [OPREDELENIYE PARAMETER SEREBRISTYKH OBLAKOV V 1964 G]
M. I. Burov Mar. 1968 19 p Transl. into ENGLISH from the Publ. "Meteorologicheskiye Issledovaniya: Serebristyye Oblaka" Moscow, Nauka Press, 1966 p 33–46
(Contract NASw-1692)
(NASA-TT-F-11520) CFSTI: HC $3.00/MF $0.65 CSCL 04A

The paper presents the theoretical basis of a stereophotogrammetrical survey of noctilucent clouds. It describes the methods of surveying used in 1964 and gives the results of the analysis of the photos obtained. Author

N68-18824*# LTV Aerospace Corp., Dallas, Tex. Astronautics Div.
ANALYSIS OF POLAR CAP ABSORPTION EVENTS. 3: TIME RELATION OF RF-H α MAXIMUM INTENSITY FOR ALL CM BURSTS $\geq 500\times10^{-22}$ W(M^{2}C/S)$^{-1}$ Quarterly Report
Fred C. Jonah 12 Oct. 1966 35 p refs
(Contract NAS9-4911)
(NASA-CR-65996; Rept.-00.865; QR-2) CFSTI: HC $3.00/MF $0.65 CSCL 04A

In support of previously investigated polar cap absorption (PCA) events, the analysis was extended to all known cases where the peak flux at one or more of the selected frequencies in the decimeter and centimeter range from 1420 through 3750 Mc/s exceeded 500×10^{-22} W(m^{2}c/s)$^{-1}$ associated with flares of importance $\leq 2^+$. The time relation of flares, RF emissions and known PCA events are discussed, along with flares of major RF emissions not followed by a PCA event. It was found that for 78% of all the flares that were not followed by a known PCA event the time of the peak RF intensity coincided with or preceded the time of the H α flare maximum. Tabulated data are included on (1) radio emissions with peak flux $\geq 500\times10^{-22}$ W(m^{2}c/s)$^{-1}$, (2) number of major RF-Hα events followed and not followed by PCA, and (3) minor flares followed by a PCA event. B.S.D.

N68-18878 Arizona State Univ., Tempe.
AN INVESTIGATION OF THE EXISTENCE AND NATURE OF LOWER OXIDES OF THE RARE EARTH ELEMENTS
Theron Leon Felmlee (Ph.D. Thesis) 1967 129 p
Available from Univ. Microfilms: HC $6.20/MF $3.00 Order No. 67-7359

Many experiments were carried out in attempts to prepare bulk amounts of RO_x ($1.5>x>0$) by reducing Sm_2O_3 and Yb_2O_3 with samarium and ytterbium respectively, reducing Sm_2O_3 in a hydrogen discharge, carbon reduction of Yb_2O_3, thermal degradation of Sm_2O_3 and controlled oxidation of SmH_2. However, only small amounts of the compound reported to be SmO could be formed, the compound reported to be Sm_2O was actually found to be SmH_2, and YbO could not be prepared. To investigate the possibility that the compound thought to be SmO was stabilized by an impurity, elemental analyses were performed and a considerable amount of nitrogen was found. Ternary compounds, $SmN_{1-x}O_x$ ($0<x\leq0.5$), were prepared, and it was found that the preparations with the composition where $x=0.5$ could explain what was previously thought to be SmO. While trying to reduce Sm_2O_3 with samarium in quartz tubes, a samarium-silicon phase resulted which has a composition of approximately Sm_5Si_3. This was ascertained by analogy between the X-ray powder diffraction pattern of this phase and those of known silicides. Dissert. Abstr.

N68-18894# United Kingdom Atomic Energy Authority, Harwell (England). Research Group.

RADIOACTIVE FALLOUT IN AIR AND RAIN: RESULTS TO THE MIDDLE OF 1967

R. S. Cambray, E. M. R. Fisher, W. L. Brooks, and D. H. Peirson Nov. 1967 51 p refs

(AERE-R-5575) HMSO: 7s

Samples of atmospheric dust and rainwater have been collected from the United Kingdom and elsewhere, and results are presented of the analyses of these samples for various fission products and certain other radionuclides. The concentrations of the long-lived fission products Cs-137 and Sr-90 in air and the deposition by rain in the United Kingdom were, in the first half of 1967, about 50% of those for the first half of 1966. During the last few months of 1966 the reduction by radioactive decay exceeded the deposition rate of Sr-90 so that, for the first time, the cumulative deposition in the United Kingdom began to decrease with time. Deposition again slightly exceeded radioactive decay during early 1967. About one-tenth of the long lived fallout in early 1967 was contributed by the Chinese explosion of 28th December 1966. This increase was sustained for several months because debris had been injected into the stratosphere. No short lived fission products (such as iodine-131) from the Chinese explosion of 17th June 1967 were detected in the United Kingdom although there is evidence of debris from this explosion in the autumn of 1967. An estimate is made of the global deposition of Sr-90 in rain to the end of 1966. Plutonium-238 from the burn up of a satellite in 1964 has been detected in surface air in the United Kingdom. Measurements of short lived fission products from the Chinese explosions of October 1966, December 1966 and June 1967, and the French tests of May–June 1967 are given in an appendix. Author

N68-18902*# National Aeronautics and Space Administration, Washington, D. C.

POTENTIAL APPLICATIONS OF SATELLITE GEODETIC TECHNIQUES TO GEOSCIENCES

1968 26 p

(NASA-SP-158) GPO: HC$0.15; CFSTI: MF$0.65 CSCL 08E

The possible applications of the techniques and capabilities of satellite geodesy to support other areas of science are assessed. Attention is centered on the nonmapping applications and the need for precise geometric and gravitational information to which the techniques of satellite geodesy can be applied. Some possible applications to the sciences of solid earth geophysics and geology, oceanography, glaciology, atmospheric sciences, technology, and space operations are summarized according to the physical quantities to be measured. The accuracies required to obtain useful information as well as the extent and frequency of coverage required are indicated. The applications are categorized according to those which can be accomplished with presently achievable accuracies; those which require an increase in accuracy with which ground stations can be located by using present satellite geodetic techniques, or an increase in the accuracy with which a satellite can be located in space at any given instant; and those requiring as yet untried instrumentation. M.G.J.

N68-18905# Adelaide Univ. (Australia). Dept. of Physics.

INSTRUCTION MANUAL FOR IONOSPHERIC DRIFT MEASUREMENTS. THE DETERMINATION OF IONOSPHERIC DRIFTS FROM THREE-RECEIVER FADING RECORDS

B. H. Briggs [1967] 38 p refs

(ADP-42) CFSTI: HC$3.00/MF$0.65

A standard form of full correlation analysis is described, and an explanation is given on the significance of the various parameters introduced to describe the pattern and its motion. The autocorrelation function of each record is computed, and the three cross-correlation functions between the records are taken in pairs. A graphical calculation method is discussed, and the factors involved in writing a computer program are identified. Details are also given on a dispersion analysis technique for determining whether different frequencies present in the fading records have the same or different velocities. The method is considered appropriate if dispersive wave motions are thought to contribute to the phenomena observed. For such waves, the velocity deduced would be a function of the frequency. The three fading records are Fourier-analyzed, and vector velocities are calculated from the phase differences between the Fourier components from pairs of records. The results are presented in graphic form to show how the speed and direction of drift vary with frequency. M.G.J.

N68-18976# Max-Planck-Institut fur Aeronomie, Lindau uber Northeim (West Germany).

REGISTRATION AND ANALYSIS OF EARTH MAGNETIC PULSATION OF POLAR LIGHT ZONE ACCORDING TO A COMPARISON WITH BREMSSTRAHLUNG MEASUREMENTS [REGISTRIERUNG UND ANALYSE ERDMAGNETISCHER PULSATIONEN DER POLARLICHTZONE, SOWIE EIN VERGLEICH MIT BREMSSTRAHLUNGSMESSUNGEN]

Klaus Wilhelm 1966 45 p refs In GERMAN *Its* Contrib. No. 27, S. 1966

A two magnetometer system is used to register earth geomagnetic pulsations during 1 to 200 sec periods by compensation principle. This system, together with a tape recorder, records pulsations of the polar light zone concurrent with balloon measurements on stratospheric X radiation. Analyses of registered observations established a close time-relationship between pulse activity and bremsstrahlung measurements during night time; day time observations of single quasi-periodic bremsstrahlung activities showed somewhat similar magnetic pulsation correlations. Atmospheric boundary layer changes and plasma dynamics of the magnetosphere induced marked pulsations at decreasing frequencies from 0.05–0.01 Hz. Transl. by G.G.

N68-18977# Max-Planck-Institut für Aeronomie, Lindau uber Northeim (West Germany).

THEORETICAL DESCRIPTION OF THE BEHAVIOR OF THE NOCTURNAL F-LAYER [THEORETISCHE BESCHREIBUNG DES VERHALTENS DER NAECHTLICHEN F-SCHICHT]

Peter Stubbe 1966 48 p refs In GERMAN *Its* Contrib. No. 26, I, 1966

The quantitative behavior of the night F layer was analyzed. A computer solution for the nonstationary ionospheric continuity equation was obtained that included the concurrent motion of neutral gases. Electron losses, ambipolar diffusion, and plasma drift currents, according to electrical fields towards north–south and west–east directions, were then used to explain the behavior of the night F layer. By this method obtained values for the ambipolar diffusion constants and the absorption coefficients agreed well with laboratory experiments. Transl. by G.G.

N68-18978# Space Instruments Research, Inc., Atlanta, Ga.

UPPER ATMOSPHERE WINDS FROM GUN LAUNCHED VERTICAL PROBES (YUMA, 16–19 NOVEMBER 1966)

Marvin Anthony and William Epler Jun. 1967 91 p refs

(Contract DA-01-009-AMC-169(X))

(BRL-CR-169-6; Rept.-6; AD-662719) CFSTI: HC $3.00/MF $0.65

On the night of 18–19 November 1966, seven luminous trails were produced between 85 km and 167 km by the release of tri-methyl-aluminum from projectiles fired from a smoothbore sixteen-inch gun located at Yuma Proving Ground, Arizona (114.2 degrees W, 32.8 degrees N). Two additional sets of four trails each were produced on the nights of 16–17 November 1966 and 19–20 November 1966. These trails were photographed by cameras located at Yuma and Gila Bend in Arizona and at Blythe, California

and have been analyzed to yield wind profiles. The report contains the tabulated wind data for all fifteen trails together with plots versus altitude of wind components, wind speed, and wind heading. Author (TAB)

N68-18996# Illinois State Water Survey, Urbana.
STUDY OF RAINOUT OF RADIO ACTIVITY IN ILLINOIS
F. A. Huff, W. E. Bradley, and P. J. Feteris Nov. 1967 19 p refs
(Contract AT(11-1)-1199)
(PR-6; COO-1199-14) CFSTI: HC $3.00/MF $0.65

Data on tritium sampling in 1966 and 1967 and radon sampling in 1967 are given. Spatial and time separation between air and water samples used preclude strong correlation in the investigation of the relation between concentration and deposition of radioactivity in rainwater and air. Studies of selected 1963 storms in which heavy concentrations of rainout were measured are described. These studies are being conducted to analyze air trajectories and to clarify processes controlling rainwater. Studies of the time distribution of radioactivity and chemical constituents in rainfall do not permit any conclusions to be drawn on the radioactive input processes in convective storms because to date the amount of data analyzed is insufficient. A workshop on tritium applications in atmospheric sciences is described. NSA

N68-19014# European Atomic Energy Community, Ispra (Italy).
SITE SURVEILLANCE WITH EURATOM JRC AT ISPRA [SORVEGLIANZA DEL SITO ALL'INTERNO DEL C.C.R. EURATOM ISPRA]
M. de Bortoli and P. Gaglione Brussels Feb. 1968 42 p refs In ITALIAN; ENGLISH summary
(EUR-3884.I) CFSTI: HC $3.00/MF $0.65

The results of the site survey measurements performed within the fence of the Ispra Establishment during 1966 and 1965, are reported and briefly discussed. It may be concluded that most of the contamination found on the site is due to the world-wide fallout. Author

N68-19015# Max-Planck-Institut fur Aeronomie, Lindau uber Northeim (West Germany).
ON A NEW OZONE RADIOSONDE AND INVESTIGATION OF AIR TRANSFER IN THE LOWER STRATOSPHERE [UEBER EINE NEUE OZONRADIOSONDE UND UNTERSUCHUNG VON LUFTTRANSPORTEN IN DER UNTEREN STRATOSPHAERE]
Peter Fabian 1967 64 p refs In GERMAN *Its* Contrib. No. 28, S 1967

Described is the design and performance of an optical ozone radiosonde that uses ozone absorption in the visible spectrum to measure sun light intensity during rocket ascent with interference spectra at 6000 Å and at 4000 Å. Intensity correlation of the two interference spectra in relation to measurement heights gives the corresponding ozone profiles. Transl. by G.G.

N68-19113# Joint Publications Research Service, Washington, D. C.
FORMATION OF AN ELECTROMAGNETIC FIELD AND ITS USE FOR SOLVING PROBLEMS IN STRUCTURAL GEOLOGY
L. L. Van'yan 11 Mar. 1968 132 p refs Transl. into ENGLISH of the book "Stanovleniye Elektromagnitnogo Polya i Yego Ispol'zovaniye Dlya Resheniya Zadach Strukturnoy Geologii" Novosibirsk, Nauka Publ. House, 1966 p 1–103
(JPRS-44637) CFSTI: HC $3.00/MF $0.65

The problem of the field formation method was solved by a spectral procedure and expressions were obtained for the transient electric and magnetic fields for a medium consisting of any number of horizontal anisotropic reference beds. The asymptotic behavior of field formation in the remote zone was investigated and tables were calculated for computing the corresponding theoretical curves. Using the concepts of apparent resistivity and effective distance, the results of the field formation method were examined from the viewpoint common to all electromagnetic soundings. The field formation process was separated into the wave and final stages which led to the establishment of the basic qualitative laws. The field investigations established the geological effectiveness of the field formation method under various conditions. The method is shown to be mobile and economical, effective in regional touring and area studies of the relief of the crystalline base, and under favorable conditions effective in the discovery and tracing of the sedimentary complex of terrigenous series prospective for oil and gas production. R.N.A.

N68-19138*# National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York.
A PHYSICAL MODEL FOR TEKTITES OF METEORITIC ORIGIN. 1: ANALYSIS OF DATA AND PHENOMENOLOGICAL BASIS
J. L. Remo and A. J. Skalafuris Oct. 1967 37 p refs Sponsored in part by AEC
(NASA-TM-X-60922) CFSTI: HC $3.00/MF $0.65 CSCL 08G

A phenomenological study is made of the shock formation of tektites from a meteorite impacting on the earth. The calculation shows that if the meteorite that caused the Ries Kessel crater ejected large fragments from the parent meteorite at speeds of ≈30 km/sec, these particles would interact with the terrestrial ejecta at the start of the recoil trajectory. A hypersonic ablation calculation at 20 km/sec is made for a single large fragment by extrapolating Hoshizaki's model for the heat transfer rate at an axisymmetric stagnation point. The results of these calculations show that this physical model can yield the size and distribution of the tektite field being considered and also account for many of the various tektite characteristics. The analysis in this paper is limited to only observations, thus all refinements which do not clarify the basic physical model have been ignored. Author

N68-19167# Joint Publications Research Service, Washington, D. C.
SOVIET-BLOC RESEARCH IN GEOPHYSICS, ASTRONOMY AND SPACE, NUMBER 176
20 Mar. 1968 112 p refs Transl. into ENGLISH from Russian
(JPRS-44734) CFSTI: HC $3.00/MF $0.65

News releases and abstracts of scientific research in the U.S.S.R. and Soviet-bloc nations are presented in the fields of geophysics, meteorology, oceanography, astronomy, and space. For individual titles see N68-19168–N68-19172

N68-19170# Joint Publications Research Service, Washington, D. C.
OCEANOGRAPHY
In its Soviet-Bloc Res. Geophys. Astronomy and Space, No. 176 20 Mar. 1968 p 33–49 refs (See N68-19167 09-13)

News items and abstracts review various studies in oceanography in the Soviet Union, including underwater crustal structure, a salinity-temperature-depth recorder, and research for shore economy. Development of a deep sea robot is noted, as is the opening of new marine scientific center, and automatic processing of oceanographic data. Application of a two-layered system for computing primary production of sea water, the geological structure of the Arctic Ocean floor, and deep circulation in the Indian Ocean are considered. Dependence of Tsunami Prope ties on character of seismic source is described, irregular wind waves in an annular hydrodynamic basin are reported, and spectral structure in the ocean current velocity field is considered. Other studies are concerned with the Ekman problem, three-dimensional circulation and three current velocity in the North Atlantic, discharge of the Antarctic

convergence into the Atlantic Ocean, and the heat regime in the Atlantic surface layer. Studies are reported on the external heat balance in the Atlantic Ocean and the Black Sea. M.W.R.

N68-19171# Joint Publications Research Service, Washington, D. C.
TERRESTRIAL GEOPHYSICS
In its Soviet-Bloc Res. Geophys., Astronomy and Space, No. 176 20 Mar. 1968 p 50–66 refs (See N68-19167 09-13)

A new geomagnetic standard for the U.S.S.R. as well as a monograph on paleomagnetism, radiogeodetic work in geophysical surveying, controlled hydrogeological sampling, and a miniature pulsed neutron source for well generators are reported in a review of terrestrial geophysics in the Soviet Union. New seismic stations are noted and a device for recording seismic signals is mentioned. Abstracts of scientific articles deal with the crustal structure of the U.S.S.R., magnetotelluric studies, and Pi12 geomagnetic pulsations at magnetically conjugate points. Geochemical characteristics of moraines of different glaciations, two-layer frequency sounding curves, filtering long-period oscillations of the 1964 Alaskan earthquake, and phase transitions and critical phenomena in the mantle are reported. A new method for determining gravity at sea, the interaction of ground water and frozen rock layers, the geoidal surface in Antarctica, and determination of point coordinates of tall objects are also reported. M.W.R.

N68-19172# Joint Publications Research Service, Washington, D. C.
UPPER ATMOSPHERE AND SPACE RESEARCH
In its Soviet-Bloc Res. Geophys., Astronomy and Space, No. 176 20 Mar. 1968 p 67–100 refs (See N68-19167 09-13)

Thirteen news articles and abstracts of 42 scientific articles are presented on upper atmosphere and space research in the Soviet Union. Soviet rocket engines, the landing site for Luna 9, docking in orbit, lunar surface composition, and Soviet–French talks on space cooperation are reported. Other articles deal with low frequency waves near the earth and in space, launching of two Cosmos satellites, radar observations on meteors, photographing artificial satellites, and the all-union conference on cosmic rays. Abstracts deal with solar cosmic ray recordings, reflection of magnetosonic waves, lunar composition and magnetic field, and hydrogen distribution in the upper atmosphere. The structure of solar corpuscular streams, ionization and variations in various atmospheric layers, and cosmic ray intensity and diffusion. A method for determining the altitude of muon production, Cerenkov flash accompanying extensive atmospheric showers, and the effect of atmospheric drag on satellite motion are reported. Other studies deal with the velocity vectors of individual meteors, meteor trails, meteor radio wave propagation, and the asymptotic directions of cosmic rays. M.W.R.

N68-19213# Defence Research Board, Ottawa (Ontario). Directorate of Scientific Information Services.
A CHART OF THE RECENT TECTONICS OF THE ARCTIC
A. P. Puminov Nov. 1967 9 p refs Transl. into ENGLISH from Dok. Akad. Nauk SSSR (Moscow), v. 175, no. 4, 1967 p 901–902 (T-487-R)

In this chart of the recent tectonics of the Arctic and Subarctic there are four special schematic insert-charts: 1) a chart of relationships of recent and ancient geostructural regions; 2) a geomorphological chart; 3) a chart of types of terrestrial crust; and 4) a distribution chart of earthquake epicenters. This is the first chart to show the recent structural forms of continents and ocean floors on the basis of the same unified principles of defining geostructural regions. Consequently, in the compilation of the chart, newly developed methods of showing the recent tectonic structures of the continental shelf and ocean basins have been employed for the first time. On the basis of trend and intensity of recent tectonic movements the chart defines continental platforms, oceanic platforms (thalassocratons), orogenic regions and geosynclinal regions. Author

N68-19217# New Mexico Univ., Albuquerque.
THE FUSION OF SOILS
J. L. Post Jul. 1967 99 p refs Prepared for Sandia Corp.
(SC-CR-67-2688) CFSTI: HC $3.00/MF $0.65

A method is provided for predicting the melt ranges of soils with ensuing vapor and gas losses; previously determined soil mineral fusion data are correlated; test soils are selected which are representative of predominant and extreme soil types of the world with their mineralogical analyses and melt range predictions given; and the results of nine soil fusion tests are included. Author (NSA)

N68-19279 Arizona Univ., Tucson.
REMANENT MAGNETIC PROPERTIES OF THE MESAVERDE GROUP, SOUTHWESTERN WYOMING AND NORTHEASTERN UTAH
Deane Earle Kilbourne (Ph.D. Thesis) 1967 148 p
Available from Univ. Microfilms: HC $7.00/MF $3.00 Order No. 67-6933

Four stratigraphic sections or representative outcrops of the Mesaverde Formation or Group of southwestern Wyoming and northeastern Utah were measured and rock cores were collected. A total of 3,447 meters of section was measured and 261 oriented rock cores were taken from the four sites. The natural remanent magnetism of 471 specimens was measured. Thermal demagnetization studies were performed in order to determine the stability and type of magnetization present. Complete thermal demagnetization of representative specimens by steps has indicated a viscous magnetization as the type present. All magnetization was lost at a temperature of 300°C. and was thermally distributed. An artificial viscous partial thermo-remanence was created by heating representative specimens to a temperature of 300°C. and cooling in the earth's magnetic field. The demagnetization of these specimens by stages was similar to that of the NRM demagnetization. The conclusion was made that the type of magnetization present is a viscous partial thermo-remanence. Dissert. Abstr.

N68-19310 Stanford Univ., Calif.
OBSERVATIONS OF WHISTLER-MODE SIGNALS IN THE OGO SATELLITES FROM VLF GROUND STATION TRANSMITTERS
Robert Linford Heyborne (Ph.D. Thesis) 1967 223 p
Available from Univ. Microfilms: HC $10.15/MF $3.00 Order No. 67-7922

Amplitude calibrated receivers aboard two satellites (OGO-I and OGO-II) are used to receive signals propagating in the whistler mode from U. S. Navy vlf stations on the ground. Existing theory is utilized to calculate the expected intensities of these signals. Measured and calculated intensities are then compared. The two satellites effectively sub-divide the whistler-mode path into two main parts: (1) the earth-ionosphere waveguide loss, the boundary and excitation loss, and the absorption loss through the ionosphere to the altitudes of OGO-II, and (2) losses due to divergence of the signal between OGO-II and the higher altitudes of OGO-I plus any additional absorption above OGO-II. These data are utilized to determine more precisely the major features and loss characteristics of whistler-mode paths inferred from previous experiments, and to determine the accuracy of attenuation rates predicted earlier by theoretical means. It is concluded that the average intensity of vlf whistler-mode signals in the magnetosphere may usually be predicted to an accuracy of ±10 db by the use of available models and existing theory. This study strongly supports present understanding of the major features of whistler-mode propagation which until now has been based largely on theoretical developments and experimental observations of naturally occurring phenomena. Dissert. Abstr.

N68-19331*# Dartmouth Coll., Hanover, N. H.
STRUCTURE OF THE MAGNETOPAUSE CURRENT LAYER
B. Sonnerup and L. J. Cahill, Jr. 22 Apr. 1966 21 p refs Presented at the 47th Ann. Meeting of the Am. Geophys. Union, Washington, 19–22 Apr. 1966 Prepared jointly with New Hampshire Univ.
(Grant NGR-30-001-011)
(NASA-CR-74933) CSCL 04A

The results of a study on the nature of the magnetospheric boundary are summarized. Explorer 12 magnetometer data were used to determine the magnetic field component perpendicular to the boundary, to study its magnetic structure, and to calculate its attitude. The study found that, with few notable exceptions, the normal field component is very small, that two fundamentally different current layer structures exist, that systematic deviations of the boundary shape occur when the solar wind is not perpendicular to the dipole axis, and that waves or bumps in the magnetospheric surface occur. R.N.A.

N68-19346* Geological Survey, Menlo Park, Calif.
IMAGERY OF CRATERS PRODUCED BY MISSILE IMPACTS
H. J. Moore, II, Reuben Kachadoorian, and J. F. McCauley (Geol. Surv., Flagstaff, Ariz.) Mar. 1968 44 p refs
(NASA Order R-09-020-015)
(NASA-CR-93685; NASA-103) CFSTI: $3.00 CSCL 08G

Infrared, ultraviolet, color, and black–white imagery of craters produced by missile impacts are useful in the study of distributions of ejecta and fallout from the craters. Detection of ejecta and fallout from the craters with infrared imagery (8–14 microns) is markedly influenced by the local topography but under optimum conditions the ejecta and fallout are shown exceedingly well as relatively cool areas on daytime imagery. The ejecta and fallout may also be detected using ultraviolet imagery (0.345–0.355 microns) but boundaries between ejecta, fallout, and the surroundings are diffuse. Color (0.38–0.78 microns) and black–white (0.45–0.71 microns) photographic imagery effectively show the distribution of ejecta in layered targets and under some conditions ejecta and fallout are also well shown. Color photography is superior to black–white photography in detection of ejecta and fallout distributions. This superiority is also evident in the black–white prints made from color transparencies which are included in this report. Author

N68-19349*# California Univ., Los Angeles. Inst. of Geophysics and Planetary Physics.
ANALYSIS OF GEODETIC SATELLITE TRACKING DATA TO DETERMINE TESSERAL HARMONICS OF THE EARTH'S GRAVITATIONAL FIELD Final Report
W. M. Kaula [1967] 23 p refs *Its* Publ. No. 656
(Contract NSR-05-007-060)
(NASA-CR-93688) CFSTI: HC $3.00/MF $0.65 CSCL 08N

Determinations of 88 tesseral harmonic coefficients of the gravitational field were made from camera tracking of seven satellites plus Doppler tracking of five satellites. It was found that addition of Doppler tracking of satellites which also have appreciable camera tracking had relatively little effect on the results. It is felt that not more than 50 of the coefficients are adequately determined. The improvement primarily required is more tracking of high inclination satellites; refinement of the dynamical theory used may also help. Author

N68-19359*# National Aeronautics and Space Administration, Washington, D. C.
CERTAIN ASPECTS IN THE INVESTIGATION OF NOCTILUCENT CLOUDS [NEKOTORYYE ASPEKTY ISSLEDOVANIYA SEREBRISTYKH OBLAKOV]
Ch. I. Willmann Feb. 1968 19 p refs Transl. into ENGLISH from the Publ. "Meteorologicheskiye Issledovaniya. Serebristyye Oblaka, No. 12" Moscow, Nauka Press, 1966 p 11–25
(NASA-TT-F-11517) CFSTI: HC $3.00/MF $0.65 CSCL 04A

The paper considers the question of climatology of noctilucent clouds (geometry, time-space characteristics, geographical, geliophysical and interplanetary conditions connected with cloud appearance), their physical nature (physical-chemical characteristics and optical properties of particles, their concentration and the brightness of noctilucent clouds) and the height, kinematic characteristics and dynamics of the noctilucent cloud field. The paper describes the activity of the World Special Geophysical Center on Noctilucent Clouds. Author

N68-19396*# Illinois Univ., Urbana. Aeronomy Lab.
STUDIES OF IONOSPHERIC ABSORPTION MEASUREMENTS
J. S. Shirke 1 Oct. 1967 132 p refs *Its* Aeronomy Rept. No. 22
(Grant NsG-511)
(NASA-CR-93694) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Several aspects of ionospheric absorption measurements are presented in this report. The phenomenon of the so-called 'winter anomaly' in ionospheric absorption is described, and various ground-based techniques normally available for the detection of the anomaly are discussed. A criterion for the detection of the anomaly is presented and successfully tested by carrying out two series of rocket measurements during normal and anomalous conditions in the winter of 1965 through 1967. A comparison of the results obtained from the rocket experiments with those derived from the ground-based techniques, shows that the winter anomaly is caused due to enhancements in electron number density in the lower ionosphere. Author

N68-19401# Royal Aircraft Establishment, Farnborough (England).
RAIN EROSION AND ASSOCIATED PHENOMENA
Aug. 1967 472 p refs Proc. of the 2nd Symp. held Meersburg, Ger., 16–18 Aug. 1967 Prepared jointly with Federal Min. for Defence
CFSTI: HC $3.00/MF $0.65

A collection of articles, presented during a conference on rain erosion, describes various simulation experiments and theoretical analyses on rain impact damage to structural materials for possible use in supersonic aircraft. Author

N68-19403# Royal Aircraft Establishment, Farnborough (England).
MULTIPLE IMPACT RAIN EROSION STUDIES AT VELOCITIES UP TO 450 M/S (M = 1.3)
R. B. King *In its* Rain Erosion and Assoc. Phenomena Aug. 1967 p 11–24 refs (See N68-19401 09-13)

A representative range of polymers, ceramics, and metals are evaluated for erosion resistances to rain densities from 1.25×10^{-6} to 1.0×10^{-5} g/cm^2. Details of experimental techniques are given as well as the methods of calculating empirical data including threshold velocities and constants of proportionality for two rain test rigs. Comparisons of weight loss, mean depth of erosion, and length of equivalent water columns striking the specimen, effects of intensity variations, and rain drop parameters show extensive damage to all materials at 450 m/s; stainless steels exhibit the most resistance under equivalent rainfall conditions. Erosion was directly proportional to rain density and, over the range 223.5 to 450 m/s, approximately proportional to the third power of test velocity minus threshold velocity. Erosion rates do not differ significantly for drops of 1.2 mm and 2.1 mm in diameter. G.G.

N68-19404# Office National d'Etudes et de Recherches Aeronautiques, Paris (France).
FIRST RESULTS OF RAIN EROSION TESTS IN THE S3 INTERMITTENT WIND TUNNEL OF THE O.N.E.R.A. MODANE TEST CENTER
Guy Fasso, Guy Leclerc, and Maurice Pletin *In* RAE, Rain Erosion and Assoc. Phenomena Aug. 1967 p 25–41 refs (See N68-19401 09-13)

Rain erosion of components of airplanes or missiles flying at high speed, implies testing in special ground facilities. Following a brief review of the existing facilities, we describe the system used at high subsonic and transonic speeds in an intermittent wind-tunnel. Actually, this system reproduces—but more rapidly—the erosion in a way that is very similar to flying in rain, as far as Mach 0.81 in heavy rain and Mach 0.83 in moderate rain. Some indications are given for improving the performance of the system. More important modifications would allow supersonic testing. Author

N68-19406# Royal Aircraft Establishment, Farnborough (England).
STRUCTURE OF CLOUDS AND RAIN FROM THE ARCTIC TO THE TROPICAL ZONE [DIE STRUKTUR DER WOLKEN UND DES REGENS VON DER ARKTISCHEN BIS ZUR TROPISCHEN ZONE]
M. Diem *In its* Rain Erosion and Assoc. Phenomena Aug. 1967 p 57–84 In GERMAN (See N68-19401 09-13)

Cloud measurements were analyzed to determine the relationship between clouds and precipitation. Results showed that high mountain point measurements can be partly correlated with the free atmosphere. A coexistence of water and ice was found in most cloud formations where single large drops represented melted crystals. Geographical differences in cloud structures were minimal; similar cloud formations possessed similar spectra. Temperature effects were much more pronounced than all geographical influences. As soon as precipitation started, the cloud spectra changed and a decrease in number of droplets started. Transl. by G.G.

N68-19407# Royal Aircraft Establishment, Farnborough (England).
DISTRIBUTIONS AND COMPOSITION OF CLOUDS AT SUPERSONIC AIRCRAFT ALTITUDES
A. J. Kantor and D. D. Grantham *In its* Rain Erosion and Assoc. Phenomena Aug. 1967 p 85–97 refs (See N68-19401 09-13)

This paper presents two aspects of radar observations of tropopause-level and tropopause-penetrating clouds. Part one deals with radar echo distributions of very high altitude convective clouds containing precipitation, as deduced primarily from a 31-station U.S. network of continuously operating WSR-57 10-cm weather radars. Part two describes ice crystal mass and concentration in a thick cirrostratus cloud, as determined experimentally by radar. For convective clouds over the U.S., radar echo probabilities are greatest over Florida and the Gulf coast, generally decreasing northward. Also, largest probabilities for most layers and locations occur in summer. Echoes have been reported up to at least 70 kft in May, June and July, and up to 60 kft in winter. In the midwest a secondary maximum occurs near midnight, and at most southeast coastal locations a weak secondary peak occurs during the early morning hours. Rough estimates are made of the distribution of high level convective clouds for other regions of the world, based on fragmentary radar observations, radiosonde analyses and analogous thunderstorm climatology. Author

N68-19408# Westinghouse Electric Corp., Pittsburgh, Pa. Developmental Div.
A SURVEY OF CLUES TO THE RELATIONSHIP BETWEEN THE EROSION SPEED AND IMPACT PARAMETERS [EINE UEBERSICHT VON SCHLUESSELN ZU DEN VERHAELTNISSEN ZWISCHEN DER EROSIONSGESCHWINDIGKEIT UND AUFSCHLAGS PARAMETERN]
F. J. Heymann *In* RAE Rain Erosion and Assoc. Phenomena Aug. 1967 p 98–157 refs (See N68-19401 09-13)

In impingement erosion the rate of material loss due to a given amount of impinging water increases strongly with impact velocity, decreases if the angle of impingement deviates from the normal, and tends to decrease if the impinging water is subdivided into smaller droplets. This survey of test data analyzes the impact pressure developed under a round drop, and the maximum value of the lateral outflow velocity after impact. A simple formulation is proposed for the value of the shock wave velocity C to be used in impact pressure calculations at high impact velocities. With respect to drop size effect, it is found that some of the experimental data can be correlated successfully on the assumption that the "threshold condition" for rationalized erosion rate is represented by V^2D = constant, where V and D are impact velocity and drop size. Finally, with respect to the impingement angle effect, there is agreement that the normal component of the impingement velocity is generally the determining factor. Author

N68-19423# Royal Aircraft Establishment, Farnborough (England).
THE IMPORTANCE OF SURFACE TOPOGRAPHY ON EROSION DAMAGE
J. E. Field *In its* Rain Erosion and Assoc. Phenomena Aug. 1967 p 370–379 refs (See N68-19401 09-13)

The work discussed in this paper is mainly concerned with the damage caused by the erosive action of the outward flowing liquid and the effect of surface topography on this damage. The paper ends with a description of erosion damage in the vicinity of a rivet head in a section taken from an aircraft wing. These results are thought to be of direct practical significance. Author

N68-19435*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
OGO-2 MAGNETIC FIELD OBSERVATIONS DURING THE MAGNETIC STORM OF MARCH 13–15, 1966
R. A. Langel and J. C. Cain Oct. 1967 43 p refs Presented at the IAGA Spec. Events Symp., St. Gall, Switzerland, 2 Oct. 1967 Submitted for publication
(NASA-TM-X-63142; X-612-68-88) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Magnetic field data from the OGO-2 spacecraft and from surface magnetic observatories are analyzed for the period March 13–15, 1966. During this interval there occurred a magnetic storm with a Dst decrease in 122γ. The results indicate a non-symmetric inflation of the magnetosphere (asymmetric ring current) with the field decrease in the dusk sector a factor of about three more than that in the dawn sector. Within the 10–30γ accuracy of the data, the field disturbance at the satellite was equal to that on the surface at the same local time. From this evidence it is concluded that the source of both Dst and DS in low latitudes are external to the satellite altitudes (410–1510 km). The disturbance observed near the dusk meridian commenced several hours sooner than that observed near the dawn meridian, reached its maximum intensity in 18 hours and then decayed in another 18 hours to the level seen on the dawn meridian. Author

N68-19452*# Ohio State Univ. Research Foundation, Columbus. Dept. of Geodetic Science.
DATA ANALYSIS IN CONNECTION WITH THE NATIONAL GEODETIC SATELLITE PROGRAM (2) Semiannual Status Report, Aug. 1967–Jan. 1968
Feb. 1968 9 p
(Grant NGR-36-008-093; OSURF Proj. 2514)
(NASA-CR-93696; SASR-1) CFSTI: HC $3.00/MF $0.65 CSCL 08E

An overview is presented on the tasks connected with investigating the geometric analysis of geodetic satellite data. These include extending computer programs for range and range rate, Doppler, and laser systems; developing data preprocessing systems to handle these data; and analyzing observational data for the National Geodetic Satellite Program. In conjunction with the development of computer programs for adjusting optical, ranging, and Doppler data in the short-arc mode, it is reported that several new features in program flexibility, computational efficiency, and completeness of mathematical expression were added to the previous

computer program in the translation from the SCATRAN language to FORTRAN 4. Theoretical investigations into sequential least-squares adjustment of simultaneous satellite observations in combination with terrestrial data were initiated. M.G.J.

N68-19486# Washington Univ., Seattle. Dept. of Atmospheric Sciences.
A STUDY OF SEASONAL CHANGES IN THE GEOMAGNETIC Sq VARIATION BY A MOTION PICTURE PRESENTATION
Masahisa Sugiura and M. Patricia Hagen Sep. 1967 28 p refs Prepared in cooperation with Emmanuel Coll.
(Grant NSF GA-478)
(PB-176284) CFSTI: HC $3.00/MF $0.65

The geomagnetic quiet daily variation Sq is analyzed for 5 consecutive quiet days in June and December 1958, using magnetic hourly data from 66 observatories. As is well known, the Sq system in the summer hemisphere is generally more intense than that in the winter hemisphere, but the relative intensities of the two systems are found to vary with UT, and during certain UT hours the Sq system in the winter hemisphere appears to become strong, sometimes its intensity exceeding that in the summer hemisphere. Average coefficients for the 5-day periods analyzed here are compared with corresponding spherical harmonic coefficients obtained by other workers for statistically determined Sq variations. Phase angles are in remarkably good agreement, and amplitudes strongly depend on solar activity. Author

N68-19491*# National Aeronautics and Space Administration, Washington, D. C.
MORPHOLOGICAL STUDIES OF NOCTILUCENT CLOUDS [MORFOLOGICHESKIYE ISSLEDOVANIYA SEREBRISTYKH OBLAKOV]
N. I. Grishin Feb. 1968 14 p refs Transl. into ENGLISH from the Publ. "Meterologicheskiye Issledovaniya Serebristyye Oblaka, no. 12" Moscow, Nauka Press, 1966 p 92–100
(NASA-TT-F-11523) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Morphological investigation constitute an important part of the problem of noctilucent clouds. Geometrical conditions of noctilucent cloud observations from the surface of the earth and from different levels of the atmosphere are shown. The photos of the crape, bands, waves and whirls of noctilucent clouds are seen as well as an example of perspective distortion and mutual screening of wave formations when observed at a small angle (15°). Further morphological investigations should be developed to determine the true physical nature of each type of structural formation and the thermodynamical conditions of their origin. Author

14 INSTRUMENTATION AND PHOTOGRAPHY

Includes design, installation, and testing of instrumentation systems; gyroscopes; measuring instruments and gages; recorders; transducers; aerial photography; and telescopes and cameras.

N68-18263# RAND Corp., Santa Monica, Calif.
PSEUDO-COLOR PROCESSING OF ELECTRONIC PHOTOGRAPHS
J. E. Rieber, Carl Gazley, Jr., and R. H. Stratton Jan. 1968 27 p refs Presented at the 1967 VAIDE Ann. Meeting, Washington, 17 Oct. 1967
(P-3743; AD-664543)

The human eye can distinguish thousands of colors, but only about 15 shades of gray. Using the S-C 4020, black and white photographs are transformed from shades of gray to shades of color corresponding to the relative intensity. This method of enhancing visibility is applied to the JPL Mariner IV photographic system test tapes of a relief map. The digital output of the camera system is converted to 64 black-and-white frames which are copied onto a single frame of color film using different color filters. Author (TAB)

N68-18296# Army Engineer Waterways Experiment Station, Vicksburg, Miss.
DEVELOPMENT OF ON-STRUCTURE STRESS GAGES Final Report
Russell W. Faust and James K. Ingram Nov. 1967 72 p refs Sponsored by DASA
(TR-1-801; AD-664127)

The report describes the development of three types of on-structure stress (OSS) gages (the IF and FS soil-pressure gages and the M-1 airblast gage) based upon the load column principle. The OSS gage design is based upon the assumption (backed by theory and experiment) that if the gage is made much stiffer than the soil, the over-registration of the gage approaches a constant value. A brief discussion of some of the unique problems of measurement of soil pressures is presented. Six OSS gages (four IF, one FS, and one M-1) were statically tested and evaluated with respect to linearity, hysteresis, resolution, thermal sensitivity, and strain sensitivity. Dynamic tests were performed in a laboratory shock tube and blast load simulator facilities. The OSS gages are concluded to be adequate for soil-pressure measurements on certain types of rigid structures and for airblast measurements, even in explosive atmospheres. They successfully measured dynamic gas pressure up to 5,000 psi in the firing tubes of the laboratory blast simulator device. Additional research is recommended to evaluate the gage performance more completely in static and dynamic soil tests. A range of soil types from coarse dry sand to moist fat clays should be investigated. Future research on gages for measuring soil pressures on structures should be concentrated on development of small gages for use with models and thin-walled structures. Author (TAB)

N68-18297# CBS Labs., Stamford, Conn.
SYSTEM DESIGN STUDY FOR RADAR LAND MASS TRANSPARENCY PREPARATION Final Report, Jul. 1966–Jan. 1967
Ivan H. Shim, Henry A. Cubberly, Gerald T. Volpe, J. Wigby, G. Webber et al Wright-Patterson AFB, Ohio AMRL Sep. 1967 137 p ref
(Contract AF 33(615)-5408)
(AMRL-TR-67-58; AD-664357)

The purpose of the program was to conduct a study for the design of a land mass transparency recording system using laser techniques. The study considered the optics necessary for focusing and modulating the laser beam, the electronics necessary to decode the tape readers input, the electronics and mechanics of the scan generation system, film stability, and human factors aspects of film handling. The rotating drum configuration was selected as the most suitable approach. The analysis delved into focusing variations due to fabrication tolerances, the control of jitter arising from bearing and motor disturbances. Author (TAB)

N68-18328# Illinois Univ., Urbana.
VISUAL FACTORS AFFECTING THE PRECISION OF COORDINATE MEASUREMENTS IN AEROTRIANGULATION
Desmond Conroy O'Connor (Ph.D. Thesis) Mar. 1967 270 p refs *Its* Civil Eng. Studies, Photogrammetry Ser. No. 6
(AD-663821)

This investigation had as its aim a study of the precision of centering black circular measuring marks in sharp circular targets simulating artificial pass-points with homogeneous backgrounds of different contrasts, imaged in the vicinity of the fovea centralis. The task was related to the general area of visual acuity, and the results confirm that the eye is remarkably sensitive to tasks of this type, threshold pointing standard deviations of the order of 0.5 seconds of arc having been obtained. The investigation went further

than recent photogrammetric tests using comparators with a least count of the order of 1 micron, which subtends a visual angle of 10 seconds at magnification 12x. Special instrumentation involving 6 meter viewing was used, with a least-count of the order of 0.02 seconds of subtended angle. The results demonstrated that the precision of pointing to artificial pass-points in aerotriangulation may be significantly affected by the size relationship between the measuring mark and pass-point, the background density, and the adaptation level, provided that the instruments used are sufficiently sensitive. Author (TAB)

N68-18369# Bendix Corp., Baltimore, Md. Avionics Div.
SELF TEST AUTOMATIC SELF CALIBRATE AND INTEGRITY MONITOR AS APPLIED TO AVIONIC EQUIPMENT
J. L. Whittaker [1967] 14 p Presented at the FAA Maintenance Symp., Oklahoma City, Okla., 7–9 Nov. 1967
(AD-664385)

Self-test features in avionic equipment can be used either in flight or on the ground to assess proper system performance. Some self-test features are not only engineered to check performance of the system but also to facilitate precise adjustment of complex systems. In general, the self-test facility involves feeding a signal of known integrity into the input of the system and reading the answer output on the associated flight instrument. Feedback control to provide automatic error correction or self calibration is a logical extension of self test in avionic equipment. With automatic self calibration the test signal is continuously or periodically applied and if an error is detected it is automatically compensated for. Thus the effects of component aging or environmental changes which would tend to cause calibration errors are obviated insuring long service life of the system. A further extension of manual self test and automatic self calibrate is integrity monitor which in effect is continuous on-line self test. The comparatively low confidence level of the warning circuits in avionic systems has been recognized by the industry for a number of years. At best, from a consideration of the circuit logic involved, the warning flags have done not much more than indicate the presence or absence of guidance signals. Safety of flight and especially of low approach and auto-land operations is intimately dependent upon the reliability and accuracy of the associated avionic sub-systems. Thus, if the output data of the guidance systems is for any reason unusable the warning circuits must be activated. Integrity monitor is the answer to this requirement. Author (TAB)

N68-18408# Utah Univ., Salt Lake City. Upper Air Research Lab.
OMNIDIRECTIONAL ELECTROMAGNETIC ACCELEROMETER
Frederick E. Templeton and Dietrich K. Gehmlich Jul. 1967 73 p refs
(Contract AF 19(628)-4055)
(UU-67-4; SR-3; AFCRL-67-0470; AD-664578)

The report describes the design of an electromagnetic accelerometer suitable for measuring the drag accelerations in the falling sphere air density experiment. This instrument uses electromagnetic reluctance forces to restrain a steel, spherical mass. A mathematical model of the system is developed and used as an analysis tool. The system is highly nonlinear and a detailed examination of the nonlinearities is made. The design criteria developed from the mathematical model are applied to the construction of a single axis prototype. The experimental results indicate feasibility of the concept, but further studies are necessary to determine the ultimate limitations of the practical system. Author (TAB)

N68-18462# Oak Ridge National Lab., Tenn.
SLIDING GENERATOR FOR TESTING MULTICHANNEL ANALYZERS
J. K. Millard 9 Nov. 1967 13 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-1989) CFSTI: HC $3.00/MF $0.65

A sliding pulse generator was developed for checking the linearity of 4000-channel multichannel analyzers in the field. This instrument is packaged in the U.S. Nuclear Instrument Module (NIM) configuration. The amplitude of the output pulses, which occur at a rate of 250 per sec, vary directly with a generated, continuously running ramp having a slope of 66.7 Mv/sec. The nonlinearity of this ramp is less than 1 part 10^4. The output amplitude can be varied, by a selector knob on the front panel, between any two voltage levels from 0 to ±10 V. By means of a differentiating circuit, the ramp slope can be monitored on a chart recorder for long-term runs. Author (NSA)

N68-19467# Bureau of Naval Weapons Representative, Pomona, Calif. Metrology Engineering Center.
TECHNICAL MANUAL INSTRUMENT CALIBRATION PROCEDURE: ELECTRONIC VOLTMETER TRUE ROOT MEAN SQUARE JOHN FLUKE 91A AND 910AR
1 Nov. 1967 20 p
(NAVAIR-17-20AE-52; PB-176719) CFSTI: HC $3.00/MF $0.65

The procedure describes the calibration of the models 910A and 910AR true RMS Voltmeters. Author

N68-18489# Aeronautical Chart and Information Center, St. Louis, Mo. Linguistic Section.
ANALYSIS OF ERRORS IN THE EXTERNAL ORIENTATION OF THE PHOTOGRAMMETRIC ELEVATION NET WITH THE USE OF PREVIOUSLY ADJUSTED SPOT ELEVATIONS OF POINTS TO BE PHOTOGRAPHED [ANALIZ OSHIBOK PRI VNESHNEM ORIYENTIROVANII VYSOTNOY FOTOGRAMMETRICHESKOY SETI S ISPOL'ZOVANIYEM PREDVARITEL'NO URAVNENNYKH VYSOTNYKH OTMETOK TOCHEK FOTOGRAFIROVANIYA]
V. I. Pavlov Oct. 1967 49 p refs Transl. into ENGLISH from the publ. "Fotogrammetricheskaya Obrabotka i Deshifrirovaniye Aerosnimkov" Leningrad, Nauka Publishers, 1967 p 67–95
(ACIC-TC-1289; AD-664096) CFSTI: HC $3.00/MF $0.65

The paper is an analysis of the problem of distortions of the elevations of the points in the photogrammetric network. After a detailed investigation of this problem six conclusions were drawn, which are briefly discussed. Author (TAB)

N68-18505# Army Dept., Washington, D. C.
THE USE OF A COLOR SCREEN FOR QUANTITATIVE INVESTIGATIONS OF SCHLIEREN BY THE TEPLER OPTICAL METHOD [PRIMENENIYE TSVETNOGO RASTRA DLYA KOLICHESTVENNYKH ISSLEDOVANII SHLIR OPTICHESKIM METODOM TEPLERA]
M. D. Apashev, V. D. Mikhaylenko, and I. F. Belyayeva 12 Jan. 1968 9 p refs Transl. into ENGLISH from Tr. Inst. Dvigateley Akad. Nauk SSR (Moscow), v. 6, 1962
(NIC-TRANS-2514; AD-664437)

A color image method with a transparent color filter made up of parallel bands of different colors as a diaphragm is proposed for quantitative investigation of nonstable optical heterogeneities. The suggested color screen method is simple to use and is adaptable for use with an existing schlieren device; and a focigram is obtained to give a visual presentation of the gradient of the index of refraction for the observed medium. M.W.R.

N68-18517* Gulton Industries, Inc., Hawthorne, Calif. Engineered Magnetics Div.
EMSE124 AC VOLTAGE MONITOR (EXPANDED SCALE) Final Report
J. A. Cox 14 Apr. 1966 46 p
(Contract NAS9-2524)
(NASA-CR-65982; EM-1907) CSCL 14B

Electrical and mechanical design data and performance specifications for the EMSE124 expanded scale ac voltage monitor

are presented. The monitor provides a zero to 5 VDC analog output which is zero at two-thirds full scale as signal input and +5 volts dc at full scale ac signal input. Included is a discussion of production problems encountered and their solutions. An acceptance test procedure which was written and used to test the preproduction units and subsequent production units is described. S.C.W.

N68-18544*# Westinghouse Electric Corp., Baltimore, Md. Defense and Space Center.

LUNAR TV CAMERA, VOLUME 1 Final Report, Oct. 1964–May 1967

1 Jun. 1967 261 p refs

(Contract NAS9-3548)

(NASA-CR-65987) CFSTI: HC$3.00/MF$0.65 CSCL 14E

Overall objectives, requirements design, development, and performance details are presented on a lunar TV camera. The camera is to provide specified performance when operated in the environments of the Command Module (CM), the Lunar Excursion Module (LEM), or on the lunar surface both during the lunar day or night. While in the CM, the camera is to be operated during the earth orbit, the translunar and transearth phases, and the lunar orbit phase of the Apollo mission; after transfer to the LEM, the camera will operate during the lunar stay time. A general description is given on the camera electronics, mechanical design and packaging, and integrated circuit development. Comments are included on the optical system, connector, and sensors, along with an assessment of the reliability and test programs. It is concluded that the camera is fully qualified for the Apollo mission, and its predicted performance either meets or betters all the specification requirements. B.S.D.

N68-18555# Air Force Systems Command, Wright-Patterson AFB, Ohio. AF Materials Lab.

AN APPARATUS FOR THE MEASUREMENT OF THE MOSSBAUER EFFECT IN THIN FILMS Technical Report, 1 Mar. 1964–1 Apr. 1965

Gerard L. Haury and Emile Rutner Nov. 1967 29 p refs

(AFML-TR-67-299; AD-664048)

The purpose of the work was to examine a specific technique for obtaining Mossbauer spectra so that properties such as nuclear magnetic moments, specific heat, local magnetic field and Debye temperature could be determined for various materials. An apparatus was constructed for the measurement of the absorption coefficient for 14 Kev gamma rays by a thin film absorber containing iron 57. The coefficient is a function of the relative velocity between the thin film absorber and an emitter (Mossbauer effect). The velocity was produced by means of a linear mechanical drive; the gamma-ray transmission rate versus velocity was automatically recorded. The system was calibrated using a cobalt-57 source diffused into a pure iron disc which radiated to an absorber of pure iron. The absorber was 1.0-mil thick; the velocity of the absorber was varied from plus or minus 0.1 to plus or minus 10 mm/sec. Both emitter and absorber were at room temperature. A Mossbauer spectrum having the same characteristic as reported by others was obtained with the apparatus. Author (TAB)

N68-18646# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ABOUT SELECTION OF OPTIMUM PARAMETERS OF VIBRATOR OF LOOP OSCILLOGRAPH [O VYBORE OPTIMAL'NYKH PARAMETROV VIBRATORA SHLEYFNOGO OSTSILLOGRAFA]

A. L'vovich and V. S. Sabaneyev *In its* Herald of Leningrad Univ., Math., Mech. and Astronomy Ser., No. 1, 1963 27 Apr. 1967 p 131–140 refs (See N68-18631 09-19)

The motion of the mirror of the vibrator is described by a linear differential equation of the third order. The dependence of the amplitude-response curve upon the coefficients of the equation is studied. Criteria are given for choosing the parameters, with which the vibrator has the amplitude-response curve with the longest horizontal part. Author

N68-18700*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

MARINER MARS ABSORPTIVITY STANDARD

T. O. Thostensen and D. W. Lewis 1 Mar. 1967 46 p refs

(Contract NAS7-100)

(NASA-CR-93489; JPL-TR-32-734) CFSTI: HC $3.00/MF $0.65 CSCL 20M

An instrument, the absorptivity standard, was used to investigate the solar absorptance of four surfaces typically used for spacecraft temperature control, the experiment being conducted as part of the Mariner IV mission. The technique consists of measuring the temperature of a flat surface which is maintained normal to the sunlight and isolated from the thermal radiation and conduction influences of the spacecraft. The absorptivity standard includes a unique thermometer for inflight temperature measurements to within 0.2°F over a 200°F range. The test surfaces were selected on the basis of their temperature control use, ultraviolet stability, emittance, solar absorptance, and spectral sensitivity; they comprise a black paint, a zinc-oxide potassium-silicate white paint, an aluminum silicone paint, and a polished metallic aluminum. A description of this instrument and a comparison between laboratory tests and the flight data for these surfaces are given. An estimate of the accuracy of these measurements is also discussed, and suggestions are offered for improvements in the design of future flight experiments. Author

N68-18764# Air Force Cambridge Research Labs., Bedford, Mass. Solid State Sciences Lab.

HIGH PRESSURE, HIGH TEMPERATURE CRYSTAL GROWTH SYSTEM

Robert C. Marshall Dec. 1967 12 p refs

(AFCRL-67-0656; AD-664335) CFSTI: HC$3.00/MF$0.65

The report describes the design, installation, calibration, and test of a unique high pressure, high temperature crystal growth system of the Solid State Sciences Laboratory of Air Force Cambridge Research Laboratories. A number of modifications and innovations that make the system unique are described. Pictures and diagrams of the crystal growth system are sufficiently complete to provide substantial aid in the operation or duplication of this facility. This furnace has been operated above 3000C at internal pressures of twenty atmospheres and at a vacuum in the low 0.00001 Torr range. Author (TAB)

N68-18773*# Texas A&M Univ., College Station. Dept. of Oceanography.

OCEANOGRAPHIC COMMENT ON APOLLO 501 MISSION PHOTOGRAPHY

Don Walsh and James E. Arnold 30 Nov. 1967 48 p refs Sponsored by NASA

(Contract Nonr-2119(04))

(NASA-CR-93429; AD-663457) CFSTI: HC $3.00/MF $0.65 CSCL 14E

The paper resulted from requests by the U.S. Naval Oceanographic Office and NASA Manned Spacecraft Center, Houston for an oceanographic appraisal of earth photography taken by the APOLLO 501 Mission on 9 November 1967. A total of 755 70 mm color photographs were taken on this mission by a Maurer camera sighted through the pilots window in the capsule. The area of photographic coverage was of the South Atlantic Ocean and Antarctica as seen from the tip of Africa. The altitude of the pictures ranged from 7,450 to 9,850 miles, however, coverage was limited by the location of the earth terminator along the west coast of Africa. As a result only a crescent shaped portion of the earth is seen. Analysis of the information content of this photography was limited by a lack of hard data on surface oceanographic and meteorological conditions for the day of the mission. The authors therefore have relied on climatological data published in standard references as the basis of interpretation. In short, this analysis provides educated speculation on this material as developed by an

oceanographer and a meteorologist. The goal of this speculation is to see whether or not future missions in this series should carry cameras and under what conditions should they be programmed.
Author (TAB)

N68-18834*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PRELIMINARY TESTS WITH MASS FLUX PROBE IN SUPERSONIC STREAM
Lloyd N. Krause and George E. Glawe Washington Mar. 1968 15 p refs
(NASA-TM-X-1524) CFSTI: HC $3.00/MF $0.65 CSCL 14B

This investigation was undertaken to determine experimentally the accuracy of a mass flux probe system using two inlet designs. One inlet design was sharp-lipped and had both the internal lip surfaces bevelled at 15° (symmetrical). A second inlet, which had only an external 15° bevel (unsymmetrical), was initially sharp and then was progressively blunted to various degrees during the test program. The purpose of using the two shapes was to compare the ideal, sharp inlet lip with the blunt lip inlets that are considered necessary to achieve adequate cooling in streams developing high stagnation-point heat-transfer rates. The Mach number of the tests ranged from 2.0 to 2.6, and the total temperature ranged from 530° to 700°R (290° to 390°K) with a tunnel inlet Reynolds number of the order of 2.5×10^6 per foot (8.2×10^6 m^{-1}). The symmetrical sharp-lipped inlet yielded excellent results, while the unsymmetrical wedge inlet with both sharp and blunt lips had an effective capture area up to 4 percent greater than the geometric capture area.
Author

N68-18852*# ITT Industrial Labs., Fort Wayne, Ind.
IMAGE DISSECTOR CAMERA SYSTEM Final Report, 2 Jun. 1965–16 Aug. 1967
20 Oct. 1967 22 p
(Contract NAS5-9619)
(NASA-CR-93406; ITTIL-67-1051) CFSTI: HC $3.00/MF $0.65 CSCL 14E

Development program and camera characteristics are reported for the Image Dissector Camera System (IDCS) designed to provide daytime cloud cover pictures of the earth from the NIMBUS B spacecraft. The IDCS is a completely electronic system that uses a vidissector with a wide angle lens capable of covering an area of 1620 by 1620 nautical miles from an orbital altitude of 600 miles. The camera operates with scene brightness ranging from 10,000 to 100 foot-lamberts with a signal-to-noise ratio at the lower illumination of 20 db. At the planned altitude, the raster to be scanned on the vidissector photocathode is 0.518×0.336 in., and resolution of the earth at the raster center is 1.73 nautical miles. The high voltage problem is considered; as are the engineering, prototype, and flight models.
M.W.R.

N68-18881# United Kingdom Atomic Energy Authority, Harwell (England). Research Group.
A CALIBRATION RIG FOR GAMMA RADIATION DOSE-RATE METERS
J. Stephenson Nov. 1967 37 p refs
(AERE-M-1763) HMSO: 6s

The code of practice for the protection of persons exposed to ionising radiation in research and teaching states that the controlling authority must ensure that instruments are tested and calibrated when they are first taken into use and re-tested at least annually. This memorandum describes the design, operation, and performance of a calibration rig designed for the routine testing and calibration of gamma radiation dose-rate meters. The test and calibration schedules for these instruments are given and the record keeping system is described.
Author

N68-18928*# National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, Fla.
METEOROLOGICAL MEASURING AND RECORDING EQUIPMENT DESCRIPTION, CALIBRATION, AND MAINTENANCE PROCEDURES FOR NASA'S 150 METER METEOROLOGICAL TOWER FACILITY, KENNEDY SPACE CENTER, FLORIDA
15 Feb. 1968 117 p refs
(NASA-TM-X-60903; GP-465) CFSTI: HC $3.00/MF $0.65 CSCL 14C

This manual provides a detailed description of various meteorological measuring systems used at the 150-meter meteorological tower facility and contains operating and maintenance procedures for all meteorological instrumentation and for each instrumentation system, including the auxiliary electronic equipment.
Author

N68-18931*# Texas Univ., Austin. Electronic Materials Research Lab.
RESEARCH ON DIGITAL TRANSDUCER PRINCIPLES, VOLUME 2 Annual Report, 1 Jan.–30 Jun. 1967
William H. Hartwig 30 Jun. 1967 65 p refs
(Grant NGR-44-012-043)
(NASA-CR-93543; AR-1, V. 2) CFSTI: HC $3.00/MF $0.65 CSCL 20L

Efforts have been directed along three lines: continued work on thin-film transport in polymer dielectrics, fabrication of semiconductor devices which have digital or discontinuous response along with mathematical models to account for their behavior, and development of capability to deposit exotic dielectrics films by chemical vapor deposition. Chemical vapor deposition of new materials has been successfully accomplished. The period was largely spent in setting up experimental facilities, and these have had some initial use which resulted in thin film of titanium dioxide. An entirely new digital transducer concept has been added to those already being studied. Work previously in progress in the laboratory on optical effects in semiconductors has revealed a photodielectric effect which can be used to convert analog light intensity into frequency changes or phase changes, depending upon the material.
Author

N68-18936# Technische Hogeschool, Delft (Netherlands).
DOUBLE FOCUSING BETA-RAY SPECTROMETER APPLIED IN HEAVY ELEMENT STUDIES
Willem Lourens 1967 98 p refs
(NP-17189)

The design and construction of a magnetic beta spectrometer using iron pole pieces to obtain a double-focusing field shape are described. Results of an investigation of the decay of actinium-225 and -226 are also presented.
NSA

N68-18947*# GCA Technology Div., GCA Corp., Bedford, Mass.
LUNAR LANDER MASS SPECTROMETER Final Report
R. F. K. Herzog and W. P. Poschenrieder Mar. 1967 22 p refs
(Contract NAS5-9393)
(NASA-CR-93545; GCA-TR-67-6-N) CFSTI: HC $3.00/MF $0.65 CSCL 20F

This report deals with the development of a sputter ion source for the Lunar Lander mass spectrometer. The new source utilizes a Penning discharge for producing the primary ions instead of the duoplasmatron which performs very well for the large laboratory instrument but has high power requirements and a susceptible hot filament. A suitable geometry and a mechanical design were determined and the characteristics of the discharge were studied in detail. The duoplasmatron of the large laboratory instrument was replaced by the Penning source to produce the primary beam. The sensitivity obtained in this way compared very

well with the sensitivity obtained with the duoplasmatron. This encouraging result concludes the first phase of the contract and renders a firm base for a successful operation of the total instrument to be developed in the following phase. Author

N68-18963# European Atomic Energy Authority, Brussels (Belgium).
BIBLIOGRAPHY ON SEMICONDUCTOR DETECTORS: A COMPILATION OF SELECTED LITERATURE ABSTRACTS AS GUIDE TO RECENTLY PUBLIC AVAILABLE R AND D PUBLICATIONS IN SEMICONDUCTOR RADIATION DETECTOR TECHNIQUES COVERING THE PERIOD 1963–1967
E. Bock Dec. 1967 135 p
(EUR-3630.E) CFSTI: HC $3.00/MF $0.65

Bibliography presenting 629 abstracts of publications dealing with Semiconductor Detector Techniques covering the period 1963–1967. Author

N68-19001*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
INSTRUMENTATION OF A SNAP-8 SIMULATOR FACILITY
James N. Deyo and William T. Wintucky Washington Mar. 1968 61 p refs
(NASA-TM-X-1525) CFSTI: HC $3.00/MF $0.65 CSCL 18D

The philosophy and experience with high temperature instrumentation, pressure sensors, thermocouples, and flowmeters are discussed. Secondary and support instrumentation in the test facility and control room are also included. The approach described is based on the parameters to be measured as well as the time schedule, physical characteristics, and available instrumentation for the facility. Results include data handling, accuracy, and reliability of the system. Over 2000 hours of operation were accumulated, during which time the mercury loop was at operating temperature for about 1000 hours. More than 2000 data runs were taken. Author

N68-19028# Kaman Aircraft Corp., Colorado Springs, Colo. Nuclear Div.
SOME PRINCIPLES OF ACTIVATION ANALYSIS
D. E. Wood Feb. 1968 73 p Presented at Conf. on Appl. of Neutron Activation Analysis in Ind., Houghton, Mich., 28 Jul. 1967
(KN-68-71(R))

An introduction to the principles of activation analysis is given. Neutron sources, instrumentation, radiation problems, typical systems, and some applications are discussed with emphasis on the fairly simple applications which lead to fully automatic systems for industrial purposes. Systems based on neutron generators, rather than reactors, are considered because of the wide potential use of these systems in production and quality control areas, as well as general analytical laboratories. Author

N68-19047*# Radio Corp. of America, Camden, N. J. Communications Systems Div.
WIDEBAND TELEVISION RECORDER Final Report
[1967] 94 p
(Contract NAS9-4629)
(NASA-CR-93526) CFSTI: HC $3.00/MF $0.65 CSCL 14C

The object of the program was to develop a variable bandwidth, miniature, television recorder/reproducer with an upper bandwidth of 4 MHz. This development was proposed to be accomplished through combination of integrated circuit electronics, a Negator-spring reeling system and a miniature helical scan recording station. Since complete instruction manuals were delivered with the equipment, this document centers largely on tests and results obtained during the development and during preacceptance tests, elaborates on design modifications, and sets forth recommendations and conclusions based on the results obtained. Author

N68-19049# Douglas United Nuclear, Inc., Richland, Wash.
FIXED RADIATION MONITORING TELEMETRY SYSTEM
W. E. Schwietert Nov. 1967 45 p
(Contract AT(45-1)-1857)
(DUN-SA-50) CFSTI: HC $3.00/MF $0.65

The design of the Fixed Radiation Monitor Telemetry System used by Douglas United Nuclear, which consists of transmitting equipment in each reactor area and a recording and alarm console installed at the Central Fire Station, is described. The purpose of the telemetry system is to provide a remote radiation station for the reactor buildings during an emergency radiation condition occurrence and to provide an audible and visual warning at the Central Fire Station of critical radiation alarm trips indicating area and time of occurrence on record of radiation levels. NSA

N68-19071# Edgerton, Germeshausen and Grier, Inc., Boston, Mass. Systems Div.
ANALYSIS OF THE CURVED CRYSTAL SPECTROGRAPH
Paul G. Wing 30 Jun. 1967 117 p refs Prepared for Calif. Univ., Livermore
(Contract AT(29-1)-1183)
(EGG-1183-387; B-3596) CFSTI: HC $3.00/MF $0.65

An analysis of a curved crystal X-ray spectrograph developed at the U. S. Naval Research Laboratory is presented. The instrument consists of a lithium fluoride crystal bent into a quarter circle so that a continuous spectrum passing through an entrance slit is analyzed by diffraction into a continuous display analogous to an optical spectrogram. Using (200) diffraction, an energy span of nearly a decade can be achieved. By suppressing the (200) spectrum and looking at the (400) reflection, this span can be extended. Instrument characteristics such as detector plane irradiance, energy dispersion, line broadening, energy resolution, and signal-to-noise ratio are derived in terms of crystal parameters and the dimensions of the instrument. Both broad and point sources are considered. No comparisons with experimental data have been made. Author (NSA)

N68-19077*# ADCOM, Inc., Cambridge, Mass.
THE DEVELOPMENT OF ADVANCED DIGITAL TECHNIQUES FOR DATA ACQUISITION PROCESSING AND COMMUNICATION Interim Scientific Report
J. Levy, E. H. Gavenman, and W. R. Bechtold 1 Nov. 1967 66 p refs
(Contract NAS12-554)
(NASA-CR-86036; G-98) CFSTI: HC $3.00/MF $0.65 CSCL 20F

Descriptions of study methodology, classification of imaging missions, imaging sensors, and image fidelity criteria are presented. A discussion of second order interpolation, and a presentation of the first pictorial material compressed thereby are contained in this report. The first simulation subjecting compressed picture data to bit errors have been completed. The effect of bit errors upon a picture compressed in accordance with zero order interpolation is displayed; the effect of the same noise upon the picture when a simple line-substitution error control scheme is employed is also displayed. A novel A/D mapping technique assigns /-bit sequences to each of the 2^{l} quantized signal levels so as to cause single bit errors to translate into large quantum level displacements. The theory that this technique causes channel errors to manifest themselves as "wild" data points which may be corrected in a run of correlated data has been tested by a computer simulation. The reliability with which wild points may be smoothed close to correct values is seen to be sensitive to the degree of sample-to-sample correlation. Author

N68-19094*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
VOYAGER SPACECRAFT PHASE B, TASK D. VOLUME 4: ENGINEERING TASKS. BOOK 5: PHOTO IMAGING Final Report
16 Oct. 1967 228 p refs
(Contract NAS8-22603)
(NASA-CR-93551; DIN-67SD4379, V. 4, Bk. 5) CFSTI: HC $3.00/MF $0.65 CSCL 14E

Scientific mission and system requirements were determined as a basis for investigating alternate methods of performing photoimaging experiments of the Martian surface from an orbiting spacecraft. Optimum coverage orbits are analyzed, along with the effects of space radiation on photographic film. Three candidate photoimaging systems were selected to meet the requirements of a general mapping mission and a spot reconnaissance mission: (1) The television system consists of vidicon sensors, camera electronics, camera programmers, and a magnetic tape recorder. (2) The photographic film system consists of cameras, high-definition silver halide film, a film processor, and a readout scanner. (3) The optomechanical scan system consists of imaging optics, scanner assemblies, point detectors with electronics, and a magnetic tape recorder. The relative impacts of the candidate systems upon the spacecraft are analyzed with respect to weight, power, volume, complexity, ability to perform a mission, necessary propulsion, and spacecraft design constraints. Data handling and storage techniques are also considered. M.G.J.

N68-19147# McGill Univ., Montreal (Quebec). Mechanical Engineering Research Labs.
THE PROBE INTERFERENCE EFFECT OF HOT WIRE ANEMOMETERS
D. C. Gilmore Jul. 1967 49 p refs
(Grant DRB-6-9551-12)
(TN-67-3)

The response of a miniature type normal hot wire probe varies not only with the normal and parallel components of velocity at the wire but also with the angle (α) made by the total normal component of velocity to the stem axis of the probe. The latter effect, called the probe interference effect, when ignored can cause errors in velocity up to 25% in highly three dimensional flows. This note describes an experimental investigation of the probe interference effect for $1/2 \leq R_{eWire} \leq 14$ for orientations $-120° \leq \alpha \leq 120°$ and $0 \leq K \leq 3$ where K is the ratio of the parallel to normal component of velocity at the wire. Measurements made on a ten times full scale model of a probe indicate that the stem body contributes approximately 50% of the total change in wire response at $\alpha = 90°$ and, the prongs 50% of the total at $\alpha = 90°$. Author

N68-19162*# TRW Systems Group, Redondo Beach, Calif. Voyager Operations Space Vehicles Div.
VOYAGER SPACECRAFT PHASE B, TASK D. VOLUME 2: ENGINEERING STUDY TASK: PHOTO-IMAGING SYSTEM Final Report
Oct. 1967 132 p ref
(Contract NAS8-22604)
(NASA-CR-93526) CFSTI: HC $3.00/MF $0.65 CSCL 14E

In order to provide optimum photographic coverage of Mars for the 1973 Voyager mission, three general types of photoimaging systems are considered. These are: (1): A hypothetical TV system, consisting of five television cameras, fulfills the requirements of low and medium resolution mapping coverage, and high resolution imaging of selected areas. (2) The recommended system consists of a television camera which may be used in either color or monochrome mode for low-resolution mapping coverage, and a film system for medium and high resolution mapping coverage. This combination of dual frame film and TV cameras is believed capable of providing the most flexible system. (3) An alternate dielectric tape and TV photoimaging system uses a television camera which may be operated in either the color or monochrome mode for low resolution mapping coverage, and a dielectric tape camera for medium resolution mapping coverage. High resolution imaging capability can be added by redesigning the dielectric tape camera. Performance characteristics and capabilities are discussed, and the relative advantages and disadvantages are assessed. M.G.J.

N68-19227# Navy Dept., Washington, D. C.
CORRECTION OF AMPLITUDE SPECTRA USING A DIGITAL COMPUTER [KORREKTSIYA AMPLITUDNYKH SPEKTROV S POMOSHCH'YU TSVM]
G. I. Zabiyakin, V. I. Prikhod'ko, V. G. Tishin, and L. P. Chellokov
26 Oct. 1967 9 p Transl. into ENGLISH from the Russian report
(NIC-TRANS-2481; AD-664435)

A method is described for correcting the amplitude spectra from semiconducting detectors using electrical pulses as references. Results show that the method can correct the amplitude spectra which are distorted due to drifts of zero and the amplification factor of the spectrometer. Depending on the available electronic equipment, the block diagram of the experiment can be changed. If the digital computer is used in the on-line regime, correction and channel summing of the codes can be activated in the process of selecting the information. In this case, the codes from the amplitude coder are fed directly to the computer and processed using only an operating memory device. In recording rare events, punched tape can be used as an external accumulator. The method is convenient when the correction procedure is part of an overall calculation process for processing spectra on a digital computer, and the computer itself is part of the experimental equipment. R.N.A.

N68-19240*# Analytic Sciences Corp., Winchester, Mass.
DESIGN OF STRAPDOWN GYROSCOPES FOR A DYNAMIC ENVIRONMENT Interim Scientific Report
Arthur Gelb and Arthur A. Sutherland, Jr. 15 Jan. 1968 174 p refs
(Contract NAS12-508)
(NASA-CR-86037; TR-101-2) CFSTI: HC $3.00/MF $0.65 CSCL 17G

A detailed error model is presented for the single-degree-of-freedom integrating gyro and the possibility of environmental vibrations generating sizeable constant drift rates in this instrument is demonstrated. A figure-of-merit relating gyro errors to the orientation error of the strapdown inertial reference system, independent of the transformation computations, is presented. An equation describing the behavior of this quantity as a function of the gyro histories is developed and exercised. Minimization of this figure-of-merit is a rational basis for the design of strapdown gyros. The question of error compensation is treated, based on the use of information derived from the gyros under consideration, as well as from additional sensors. In this connection, a scheme for gyro monitoring is advanced. Two simplified strapdown gyro design examples are presented, in which the binary torqued rebalance loop is characterized using a quasi-linearization description and random vibrational motions are described through a simple approximation. In minimizing the figure-of-merit, the optimized gyro designs are shown to be mission dependent. Author

N68-19281 Texas Univ., Austin.
VACUUM X-RAY SPECTROSCOPY AND THE K ABSORPTION EDGE OF ALUMINUM
Robert Scott Wriston (Ph.D. Thesis) 1967 64 p
Available from Univ. Microfilms: HC $3.60/MF $3.00 Order No. 67-8175

A new type of vacuum double crystal X-ray spectrometer movement was designed and constructed. Both the X-ray tube and detector remain fixed, and the crystals pivot on arms about a common center. Riders, which move on a finely threaded screw having half right handed and half left handed threads, position the

arms so that the angle between the crystals can be varied in a uniform, accurate manner. A windowless X-ray tube and high quality quartz crystals were used. A commercial proportional counter tube was found to be capable of detecting M-series radiation of tungsten. An open electron multiplier tube was modified by coating the photocathode with magnesium metal. The M-series tungsten lines were detected with the electron multiplier, but stray counts from softer radiation and other sources caused background counts as high as one hundred and fifty counts per minute. Dissert. Abstr.

N68-19301# Technische Hogeschool, Delft (Netherlands).
CONSTRUCTION OF AND MEASUREMENTS WITH A BETA-RAY SPECTROMETER FOR ELECTRON-GAMMA CORRELATIONS
Hans van Krugten [1967] 89 p refs
(NP-17188)

A survey is made of different types of beta spectrometers in order to select the best one for electron-gamma correlation experiments. The sector type spectrometer with a $B = B_0/r$ field and with an opening angle of 20° was chosen. A value of about 1.5 for the ratio of transmission and resolution was obtained. The maximum transmission was found to be about 2%. The best resolution is about 0.5% for sources with a diameter of 2 to 3 mm. The influence of stray fields upon a second spectrometer (generally a NaI(Tl)-crystal equipped with a photomultiplier) for directional correlation measurements was made negligibly small by surrounding the multiplier by magnetic shields. To produce radioactive sources for beta-ray spectroscopy a vacuum deposition instrument was built. A new type of crucible leading to improved efficiency was designed. Several measurements carried out with the spectrometer are described. The shape of the low energy part of the beta continuum of the 962 keV branch in the decay of ^{198}Au was investigated by comparing this spectrum with that of the 913 keV beta branch in the decay of ^{89}Zr. The latter is assumed to have statistical shape. Beta spectra from the decay of ^{228}Ac and from the decay of the daughter products of ^{225}Ac were investigated. Various measurements were performed on the decay of ^{154}Eu. The K/L and L/M ratios for the internal conversion of the 123 keV transition in the daughter nucleus ^{154}Gd were measured. By means of gamma–gamma and conversion electron–gamma correlation experiments the $b_2(e_K, 123\ keV)$ and the $b_2(e_L, 123\ keV)$ particle parameters were measured. Author (NSA)

N68-19309*# Block Engineering, Inc., Cambridge, Mass.
SINGLE CHANNEL AIRBORNE INFRARED RADIOMETER Final Report
Herman De Weerd 4 Jan. 1968 22 p
(Contract NAS9-6817)
(NASA-CR-92009) CFSTI: HC $3.00/MF $0.65 CSCL 20F

The design and fabrication of a radiometer and a blackbody, which is used as a calibration standard for the radiometer, are described. The radiometer will be flown over land and water in conjunction with a spectro radiometer and a visual mapper. The precision of the calibration blackbody is 0.02°C for temperatures within 15°C of environment temperature and 0.08°C at the highest temperature (71°C). The greyness of the blackbody is excellent and its level of emission is between 0.4 and 0.7% of the theoretical values. In addition, the temperature control and display of the cavity are highly accurate. The radiometer's thermal dynamic range of between −40° and +70°C was demonstrated as well as its thermal resolution of 0.1°C over the entire range. When the reference source temperature is within 10°C of the target temperature, the thermal resolution is 0.03°C. This is apparently due to the higher than necessary signal to noise ratio of 10 and a higher efficiency than was initially estimated. The instrument has a field of view of 24.5 to 27 arc-minutes and an accuracy, as referenced to the calibration blackbody, of between 0.1° and 0.4°C. R.N.A.

N68-19320*# Ryan Aeronautical Co., San Diego, Calif.
PRELIMINARY DESIGN FOR A RUGGEDIZED IMAGING SYSTEM Final Engineering Report, 9 Jan.–11 Aug. 1967
A. A. Harmon 20 Oct. 1967 87 p Prepared for JPL
(Contracts NAS7-100; JPL-951572)
(NASA-CR-93676; Rept.-29169-9) CFSTI: HC $3.00/MF $0.65 CSCL 20F

This report summarizes the results of a developmental effort to redesign the Mariner C television camera utilizing contemporary components and techniques to realize an immunity to the effects of sterilization and high impact shock. A complete functional ruggedized imaging system breadboard was designed, developed and tested. The design incorporates features which, when advanced to the prototype stage, will contribute significant resistance to the effect of high impact shock and sterilization procedures. Operating at three-fourths the power of the Mariner C imaging system, the measured performance was superior to that of its predecessor. It would also be considerably lighter and smaller when packaged as the Mariner C imaging system. Author

N68-19338*# Utah Univ., Salt Lake City. Dept. of Electrical Engineering.
A THERMOMETRIC FILM SIMULATOR AND AN APPLICATION TO THE FILM MOUNT OF THE ARCASONDE 1A SENSOR Progress Report
Forrest L. Staffanson and Shigetaka Kikkawa Nov. 1967 59 p refs
(Grant NGR-45-003-025)
(NASA-CR-66579; UTEC-MR-67-079) CFSTI: HC $3.00/MF $0.65 CSCL 09A

A Fortran program is presented which uses the alternating direction implicit method of two-dimensional numerical integration for the calculation of the time-dependent temperature distribution over a planar thin plate having an arbitrary distribution of conductive, convective, and radioactive properties and boundary conditions. The program is applied to the film mount of the ARCASONDE 1A meteorological rocketsonde temperature sensor. Observations are made relative to the film performance at 60 and 70 km altitude, particularly concerning conductive isolation from support posts, speed of response, susceptibility to radiation, and the heat conduction from attached thermistor and sonde wires. Author

N68-19374# Battelle-Northwest, Richland, Wash.
TECHNIQUE TO EVALUATE PROCESS CONTROL AND DATA HANDLING INSTRUMENTATION
W. R. Markillie Aug. 1967 97 p refs
(Contract AT(45-1)-1830)
(BNWL-447) CFSTI: HC $3.00/MF $0.65

A figure-of-merit model was developed to evaluate several process control and data handling instrumentation concepts proposed for the Fast Flux Test Facility (FFTF). The model first provides for the consideration of each instrumentation concept according to its performance in terms of safety, operating continuity, data handling, control quality, human factors and flexibility. It then directs the comparison of that performance with process control and data handling requirements included as part of the evaluation technique. The result of such a comparison is a measure of instrumentation concept worth expressed both qualitatively and quantitatively. The measure of worth and the cost of each concept become a basis for comparing the concepts and lead to the selection of one of them for FFTF. Author (NSA)

N68-19385*# Electro-Optical Systems, Inc., Pasadena, Calif.
SOLAR WIND SPECTROMETER PROJECT Final Report, Apr. 1966–Jan. 1968
10 Feb. 1968 107 p Prepared for JPL
(Contracts NAS7-100; JPL-951519)
(NASA-CR-93667; EOS-7069-FR) CFSTI: HC $3.00/MF $0.65 CSCL 20F

The purpose of the Solar Wind Spectrometer (SWS) project was to develop, fabricate, and test flight instruments for measuring solar wind characteristics on the lunar surface. An outstanding characteristic of the SWS is its large acceptance angle. This angle is obtained by seven sensor cups positioned approximately equidistant from each other on the surface of a hexagonal cupola. The basic solar wind sensors are modified, five-grid Faraday cups. These cups detect fluxes to about 10^5 particles per cm^2 per second, which produce current outputs to the electronics of 6×10^{-13} ampere. The SWS repeats 16 sequences of 186 measurements per sequence every 449.6 seconds in normal operation. Each sequence includes a measurement of 14 proton and 7 electron energy windows from each of the seven sensors. Author

N68-19451*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
ANALYSIS OF APOLLO AS-501 MISSION EARTH PHOTOGRAPHY
John E. Dornbach, comp. Feb. 1968 70 p ref
(NASA-TM-X-58015) CFSTI: HC$3.00/MF$0.65 CSCL 14E

The application of orbital photography in the sutdy of earth resources is assessed, based on the acquisition and return of the highest altitude, color photographic-emulsion imagery ever made of the earth. The Apollo AS-501 mission objectives are described, and details are given on the camera, film, and film processing equipment and techniques. Due to scale and resolution limitations, no scientific data analyses could be performed in geology, geography, hydrology, or cartography. However, in meteorology and oceanography, several specific comments were made by the Environmental Science Services Administration, and the U. S. Naval Oceanographic Office. Among them are the following: (1) In comparing the Essa 3 satellite views of the tropical Atlantic with those obtained from the Apollo spacecraft, color photography appears to facilitate the capability to differentiate between deep and shallow convective cloudiness. (2) The photography is dramatic evidence of the importance of understanding how cloud patterns relate to sea surface circulations and mirror ocean temperature patterns. M.G.J.

N68-19464# Environmental Science Services Administration, Oak Ridge, Tenn. Atmospheric Turbulence and Diffusion Lab.
A COMPACT, PORTABLE, TEMPERATURE RECORDER
Warren B. Johnson, Jr. Oct. 1967 9 p ref
(IERTM-ATDL-6; PB-176567) CFSTI: HC$3.00/MF$0.65

The report describes an instrument that is suitable for use on a small airplane, to take horizontal and vertical profiles of air temperature. Author

N68-19468# Bureau of Naval Weapons Representative, Pomona, Calif. Metrology Engineering Center.
TECHNICAL MANUAL INSTRUMENT CALIBRATION PROCEDURE. RADIO TEST SET AN-TRM-1
1 Nov. 1967 23 p
(NAVAIR-17-20VQ-03; PB-176519) CFSTI: HC$3.00/MF$0.65

The procedure describes the calibration of the AN/TRM-1 radio test set, which consists of the SG-32/TRM-1 and SG-33/TRM-1 signal generators, TS-687/TRM-1 test set subassembly, and accessories. Author

15 MACHINE ELEMENTS AND PROCESSES

Includes bearings, seals, pumps, and other mechanical equipment; lubrication, friction, and wear; manufacturing processes and quality control, and reliability; drafting; and materials fabrication, handling, and inspection.

N68-18354# Walter Kidde and Co., Inc., Belleville, N. J.
DESIGN AND FABRICATION OF A SMALL LIGHTWEIGHT EXPENDABLE TYPE GAS CYLINDER FOR USE WITH HELIUM Final Scientific Report, May 1966–Nov. 1967
T. F. Hunter Dec. 1967 51 p refs
(Contract AF 19(628)-6050)
(R-1919; AFCRL-67-0676; AD-664354)

The program was undertaken to design and fabricate a pilot run quantity of a small lightweight expendable type cylinder and valve assembly charged with helium to be used by combat weather teams for inflating small meteorological balloons. The cylinders were designed with an internal volume of fifteen cubic inches to contain 1.6 to 1.8 free cubic feet of helium at a filling pressure of 3600 psig and a temperature of 70F. The cylinder assembly was designed to be sealed after filling, with gas discharge accomplished manually by means of a pierced disc technique, using a non-integral puncturing stem device. The assembly was designed to permit seal-off and flow control after disc puncture by manipulation of the stem. TAB

N68-18365# Royal Aircraft Establishment, Farnborough (England).
SOME CHARACTERISTICS OF A ZEOLITE ADSORPTION PUMP
L. G. Carpenter and R. W. Bramham Jul. 1967 29 p refs
(RAE-TR-67150; AD-664524)

Experiments on the pumping performance of a somewhat crude but serviceable design of adsorption pump using zeolite 5A are described, the refrigerants being liquid nitrogen or solid CO2 in alcohol, and the pumped gases being air, N2, CO2, He, Ne and Ar. Constructional details of the pump and data on chill time and consumption of refrigerant are included. Author (TAB)

N68-18377# Rock Island Arsenal Lab., Ill. Research and Engineering Div.
SOLID FILM LUBRICANT WEAR LIFE UNDER VARIOUS TEST PARAMETERS
George Murphy, Jr. Oct. 1967 43 p refs
(RIA-67-2548; AD-663814) CFSTI: HC$3.00/MF$0.65

Representative solid film lubricants were evaluated under various combinations of load and speed. Coatings were applied to both rotating and stationary test specimens which had been grit blasted and zinc phosphatized prior to application. Coatings were cured in accordance with the specification requirements. The following general conclusions may be made from the study: (1) Wear life of the coating is dependent on load, speed, bearing configuration and the type of solid lubricant, (2) wear life usually decreases with increased load, however in some cases in the lower load range it remained constant, (3) the effect of speed depends on how wear life is expressed, if it is expressed in minutes it was found that coating life decreases with increasing speed except for a few cases where it remained constant. When wear life is expressed in linear feet it may increase, decrease or remain constant with increasing load, (4) the order in which a solid lubricant coating is ranked depends upon the machine used in evaluating it, (5) no single bench testing machine can be used to predict the service life of solid film lubricant coatings. Author (TAB)

N68-18429# Aerospace Corp., El Segundo, Calif. Materials Sciences Lab.
CRITERIA FOR FASTENER SYSTEM DESIGN
Louis Raymond, E. George Kendall, and James K. Stanley Oct. 1967 29 p refs
(Contract F04695-67-C-0158)
(TR-0158(3250-10)-2; SAMSO-TR-67-94; AD-664546)

Criteria for fastener system design are suggested. The application of system analysis to mated parts held together with a high-strength fastener is discussed. The torque-tension relationship

of each system should be measured, and fracture mechanics should be used to index environmental compatibility. This approach can also be used to produce a cost-effective fastener system design. Author (TAB)

N68-18437# Air Force Systems Command, Wright-Patterson AFB, Ohio. Air Force Aero Propulsion Lab.

A TECHNIQUE FOR APPLYING THE FINISH SURFACE OF LARGE-AREA PLATFORMS USED FOR GAS-BEARING ZERO-G SIMULATORS Technical Report, May 1966–Aug. 1967

John B. Catiller and John A. Herman Nov. 1967 36 p
(AFAPL-TR-67-119; AD-664334)

This report describes a method of applying special epoxy resin compounds on stable surfaces to obtain very flat (less than 0.0003-inch variation) smooth (1 to 2 microinch) surfaces over large areas (800 square feet). The technique is simple, quick, relatively inexpensive, and can be used on any area where such surfaces are required, including gas-bearing platforms and large surfaces for precision measurements. Author (TAB)

N68-18599*# Martin Co., Baltimore, Md.

SUPPORT MANUAL FOR APOLLO LUNAR SURFACE DRILL (ALSD)

15 Mar. 1967 105 p
(Contract NAS9-6587)
(NASA-CR-65971; DSM-2; ER-14523) CFSTI: HC $3.00/MF $0.65 CSCL 13I

The purpose of the ALSD is to provide a means for a single astronaut to implant heat flow temperature probes below the lunar surface and collect subsurface cores. This requires the drilling of subsurface holes to a maximum depth of three meters. The support manual contains the equipment descriptions, operating procedures, and support instructions necessary to maintain the ALSD at a field level of operation. Major areas covered in the manual include: (1) equipment descriptions with major part number identifications; (2) ALSD operating procedures; (3) service instructions; (4) prelaunch operations at Kennedy Space Center; (5) transportation and storage requirements; and (6) spares list. K.W.

N68-18625*# Automation Industries, Inc., Boulder, Colo. Research Lab.

DEVELOPMENT OF THE ULTRASONIC TECHNIQUE FOR ALUMINUM WELDS AND MATERIALS, PHASE 1

K. J. Hannah and B. T. Cross 2 Oct. 1967 67 p refs
(Contract NAS8-18009)
(NASA-CR-61585; TR-67-59) CFSTI: HC $3.00/MF $0.65 CSCL 13H

The Delta Technique is a unique, multi-crystal inspection method that is relatively insensitive to defect orientation. Internal weld defects including lack of penetration and lack of fusion were readily detected when using this technique. Test demonstrated that the Delta Technique successfully detected the weld defect of primary concern in 2014 and 2219 aluminum alloy weldments at inspection rates of 50 feet per hour. Lack of penetration of a 0.030" × 0.060" size and lack of fusion as narrow as 0.025" were reliably detected. Microfissuring, a laminar shrinkage type defect found in 3/16" and 1/4" weld sections was detected by the Delta Technique where radiographic techniques failed because of unfavorable defect orientation. Correlation of the nondestructive tests showed that up to 80% of the total defects were detected by the Delta Technique while only 36% of the total defects were detected with radiography. A prototype manual Delta was constructed and evaluated in the laboratory. Author

N68-18692# Air Force Systems Command, Wright-Patterson AFB, Ohio. Systems Engineering Group.

RELIABILITY PROGRAMS FOR AEROSPACE SYSTEMS AND THE BAYES THEOREM TO ASSURE RELIABILITY

Samuel R. Porter 10 Aug. 1967 16 p refs
(SEF-TN-67-5; AD-664586) CFSTI: HC $3.00/MF $0.65

The development of the Bayesian approach will provide a tool for the accomplishment of the present reliability assessment requirements which are not being met by classical statistical methods. Utilization of the Bayesian assessment early in the component development program will provide for efficient and economical use of funds rather than making later decisions in the interest of reliability which are extremely costly or funds may not be available. TAB

N68-18777*# Battelle Memorial Inst., Columbus, Ohio.

FEASIBILITY STUDY OF RESISTANCE WELDING OF ALUMINUM ALLOYS, STAINLESS STEEL, AND TITANIUM IN A HARD VACUUM Final Report, Jun. 27, 1967–Feb. 29, 1968

D. L. Cheever, D. G. Howden, and R. E. Monroe 29 Feb. 1968 37 p refs
(Contract NAS8-21196)
(NASA-CR-61596) CFSTI: HC $3.00/MF $0.65 CSCL 13H

An investigation was made of the feasibility of resistance spot welding aluminum, stainless steel, and Ti–6Al–4V alloy in a hard vacuum. The planning of the experiments and physical equipment is reported and the making of weldments both in air and in vacuum using conventional resistance welding techniques are described. Weldment quality was evaluated by inspection of X-ray films and weld cross sections. Tensile strength of the welds was determined and the data were analysed to show in what ways welds made in air differed from those made in a vacuum. The resulting graphs provide guidelines for determining welding conditions in space once the welding conditions in air are known. A final analysis was conducted to determine what function and capabilities would be required for spot welding in space. A discussion of desirable features and recommendations of guidelines for equipment design was also included. Author

N68-18872# Los Alamos Scientific Lab., N. Mex.

PIPE CLOSURE BY EXPLOSIVES

J. D. Harper 5 Dec. 1967 9 p
(Contract W-7405-ENG-36)
(LA-3786) CFSTI: HC $3.00/MF $0.65

High explosives were used to close aluminum, copper, and steel pipes in various sizes up to three feet in diameter. Closure times of less than one millisecond are typical. Author (NSA)

N68-18948# Max-Planck-Institut fur Stromungsforschung, Gottingen (West Germany).

THE PUMPING HEAD RATIO OF RADIAL CENTRIFUGAL PUMPS EMPLOYING LOGARITHMIC-SPIRAL-SHAPED BLADES

A. Busemann [1967] 26 p refs Transl. into ENGLISH of the book "Das Foerderhoehenverhaeltnis Radialer Kreiselpumpen mit Logarithmisch-Spiraligen Schaufeln" Germany Submitted for publication

The attempt to approach the solution of the entire problem by means of an over-simplified transformal function, and to derive the required correction functions from the known pumping head at an infinite number of blades remains only an approximate solution which deviates from the actual solution in a way that is very difficult to express mathematically. It is therefore assumed that quite a few readers would like to know the accurate solution, if only as a means of comparison for a few values. This assumption inspired the study at hand, and it seems therefore appropriate to write it

in close reference to the paper by Schulz. On the other hand, this paper should also be comprehensible independently, especially as it will show the accurate solution in a very simple and useful form by graphical representation and linear transformation of the blades of the z^{th} power at the same blade angle but with reduced inner radius. Author

N68-18973*# Lockheed Missiles and Space Co., Sunnyvale, Calif.
BERYLLIUM FABRICATION METHODS DEVELOPMENT PROGRAM: THERMAL TREATMENT
2 Jul. 1965 63 p ref
(Contract NAS8-11798)
(NASA-CR-61659; LMSC/A758461) CFSTI: HC $3.00/MF $0.65 CSCL 13H

This report documents the thermal treatment techniques investigated and evaluated for possible application in the fabrication of beryllium aerospace vehicle structures. The effects of time and temperature on the removal of residual stresses, induced by prior work, are evaluated. The physical, mechanical, and dimensional changes resulting from varying rates of rapid cooling are reported; and the effects of prolonged exposure at high temperatures on the mechanical properties of beryllium sheet are investigated. Author

N68-18993*# Battelle Memorial Inst., Columbus, Ohio.
EVALUATION OF LUBRICANTS FOR HIGH-SPEED HIGH-TEMPERATURE APPLICATIONS Summary Report
J. W. Kannel, J. C. Bell, R. R. Riopelle, and C. M. Allen Nov. 1967 82 p refs *Its* Sum. Rept. No. 1
(Contract NAS3-7270)
(NASA-CR-72346) CFSTI: HC $3.00/MF $0.65 CSCL 11H

Research has been conducted to determine the feasibility of using a rolling-disk apparatus to evaluate lubricants for high-speed, high-temperature applications such as the SST. The instrumentation to be used with the apparatus includes an X-ray technique for measuring the thickness of the lubricant film between the disks and a dielectric breakdown scheme for detecting surface-to-surface contact. A detailed study has been conducted to define a disk geometry which best simulates the contact geometry of a 120 mm bore angular-contact ball bearing. From the results of this study, it was determined that the disks should be 1.4 inches in diameter and have a crown radius of 11 inches. Both cylindrical-crowned disks and coned-crowned disks should be used, the latter to simulate sliding conditions due to ball spin. Cylindrical-crowned disks of M-50 bearing steel have been fabricated. Check-out experiments have demonstrated the basic capability of the disk machine to duplicate the required operating conditions. Preliminary exploratory experiments with the similitude disk have indicated that only a very thin lubricant film is formed between bearing elements at temperatures around 600 F, under moderate loads and speeds, when the fluid designated XRM-177 is utilized. At a milder temperature, 400F, films between 3 and 8 microinches are formed. Author

N68-19027# Du Pont de Nemours (E. I.) and Co., Aiken, S. C.
PERFORMANCE OF CENTRIFUGAL MIXER SETTLER IN THE REPROCESSING OF NUCLEAR FUEL
D. S. Webster, A. S. Jennings, A. A. Kishbaugh, and H. K. Bethmann 16 Oct. 1967 19 p refs Presented at the Symp. on Recent Advan. in Reprocess. of Irradiated Fuel, Am. Inst. of Chem. Eng. Meeting, New York, 26–30 Nov. 1967 Submitted for publication
(Contract AT(07-2)-1)
(DP-MS-67-71; CONF-671103-4) CFSTI: HC $3.00/MF $0.65

An eighteen-stage centrifugal mixer-settler, designed and developed at the Savannah River Laboratory, is now successfully separating plutonium and uranium from radioactive fission products. The design of the mixer-settler and tests that were conducted before installation of this equipment, and performance with radioactive solutions is described. Advantages of the centrifugal equipment over a pump-mix mixer-settler are associated principally with the smaller liquid volume holdup (1/50), and include reduced exposure of the solvent to radiolytic degradation, increased nuclear safety, easier flushing, and greater operating flexibility. The unit has a capacity of over 60 gpm total flow. In the new mixer-settler, pumping, mixing, separating, and decanting are all performed in a single device having a single rotating shaft. A particular feature of the new mixer-settler is the use of air pressure in a weir chamber to regulate remotely the emulsion position in the centrifuge. The centrifugal stages have high mass transfer efficiency; for example, an overall efficiency of ≈95% is attained in stripping uranium from solvents. The unit has been performing well since startup, decontamination and losses are satisfactory, solvent picks up only 1/5 as much gamma activity as it did in the pump-mix mixer-settler, and shutdowns and startups are made rapidly without extensive flushing. Author (NSA)

N68-19052# Thermo Electron Engineering Corp., Waltham, Mass.
RESEARCH AND DEVELOPMENT OF VACUUM FOIL TYPE INSULATION FOR RADIOISOTOPE POWER SYSTEMS Quarterly Progress Report, Sep.–Nov. 1967
J. B. Dunlay, J. Fronduto, E. Peredetto, M. L. Paquin, and V. L. Poirier 29 Dec. 1967 103 p
(Contract AT(30-1)-3634)
(TE-4059-77-68; ALO-3634-7) CFSTI: HC $3.00/MF $0.65

Phase II of the development of high-temperature thermal insulation is described. Thoria powders containing small (1/μ), medium (≈20 μ), and large (≈50 μ) particles were purchased. Spraying experiments established that the deposited particle size is independent of the spray mixture rolling time and the spray gun pressure. The deposited particles were the same size as the original particles. In order to standardize the spray pass, an automated foil spraying appratus has been designed and fabricated. 400 feet of 1 mil tungsten foil and 50 feet of 1/2 mil tungsten 25% rhenium foil has been purchased. The tungsten will be chemically etched to 1/2 mil. The ability to deep draw thin molybdenum foil cups has been developed. These cups can be used to fabricate insulation corner assemblies. The Phase I computer program is being revamped to analyze a concentric cup corner. Author (NSA)

N68-19243# Union Carbide Corp., Oak Ridge, Tenn.
A SPARK-GAP TOOL-SETTING SYSTEM
C. Asmanes 20 Sep. 1967 17 p
(Contract W-7405-ENG 26)
(Y-1589) CFSTI: HC $3.00/MF $0.65

An automatic tool-setting system has proven satisfactory for most machine tools requiring a high degree of accuracy in establishing tool position. The system utilizes a spark, between a probe or tool-setting station and the cutting edge of the tool, to establish a point as a repeatable gap for tool positioning. The system permits the machining of parts to very close tolerances on a production basis. Author (NSA)

N68-19307*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
SHAPING OF PRECIPITATION-HARDENING STAINLESS STEELS BY CASTING AND POWDER-METALLURGY
J. G. Kura, V. D. Barth, and H. O. McIntire [1968] 51 p refs Prepared by Army Missile Command and Battelle Mem. Inst.
(NASA Order H-76715; Contract DA-01-021-AMC-11651(Z))
(NASA-SP-5086; RSIC-491) CFSTI: HC $3.00/MF $0.65 CSCL 13H

The state of the art of making shapes of precipitation-hardenable stainless steels by methods other than machining from wrought materials is reviewed. The methods reviewed are casting and powder metallurgy. Of these methods, only casting is

extensively practiced. Powder metallurgy is a promising procedure for 17-4 PH stainless, but techniques are not well advanced for handling the grades that contain titanium or aluminum such as PH 15-7 Mo and A-286. Author

N68-19343*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
SURFACE TREATMENTS FOR PRECIPITATION-HARDENING STAINLESS STEELS
[1967] 64 p refs Prepared by Battelle Memorial Inst.
(Contract DA-01-021-AMC-11651(Z))
(NASA-SP-5090; RSIC-595) CFSTI: HC $3.00/MF $0.65 CSCL 13H

In this report, selected surface treatments that are applied to precipitation-hardenable stainless steels are discussed. The treatments covered are hard surfacing, electroplating, electroless plating, carburizing and decarburizing, nitriding, burnishing and other finishing operations, explosive hardening, planishing, and peening. Each treatment is described and its application to the precipitation-hardenable stainless steels is discussed. Reasons for using the treatments are discussed, problem areas are identified, and recommendations for research are made. Author

N68-19387# TRW Systems Group, Redondo Beach, Calif.
STUDY OF THE CHEMICAL INTEGRITY OF RADIOISOTOPE CONTAINMENT MATERIALS IN LAUNCH ABORT ENVIRONMENTS. PHASE 3: BEHAVIOR OF GRAPHITIC MATERIALS
W. Gregson, Jr. Apr. 1967 38 p Prepared for Sandia Corp.
(SC-CR-67-2595) CFSTI: HC $3.00/MF $0.65

The study of the reactions of two commercial graphites when subjected to controlled flame environments is presented. Author (NSA)

16 MASERS

Includes applications of masers and lasers. For basic research see: 26 Physics, Solid State.

N68-18268# Cornell Univ., Ithaca, N. Y. School of Electrical Engineering.
RESEARCH ON A TUNNEL LASER Final Report
J. M. Ballantine Nov. 1967 12 p refs
(Contract DA-31-124-ARO(D)-364)
(MSC-839; AROD-5560.6-E; AD-664168)

A summary is given of work which proceeded along three principal lines: (1) Theoretical evaluation and prediction of tunnel-laser performance and operating characteristics; (2) measurement and interpretation of photon loss mechanisms in active and passive gallium arsenide; and (3) experimental and theoretical investigation of electroluminescence in tunnel-laser structures utilizing gallium arsenide as the semiconducting and silicon monoxide as the insulating components. TAB

N68-18279# Institute for Defense Analyses, Arlington, Va. Science and Technology Div.
A THEORY OF HIGH FREQUENCY LASER-INDUCED INSTABILITIES IN GASES
Peter M. Livingston Dec. 1967 28 p refs
(Contract DAHC15-67-C-0011)
(P-361; AD-664487)

A theory is presented which treats the problem of high frequency instabilities generated in a gas by laser radiation. Transport processes enhanced by sound pumping of low-lying rotational and vibrational states contribute to a strong high frequency dispersion in carbon dioxide and air. For a light-absorption power-product (alpha P)Mw/cu cm, the gain lengths of the most unstable modes in CO2 and air are L-CO2 =0.33(alpha P) to the -1/2 power, L-air = 0.1(alpha P) to the -1/2 power. The result shown for air is several orders of magnitude smaller than previously reported. Author (TAB)

N68-18316# Army Electronics Labs., Fort Monmouth, N. J.
MEASUREMENT OF THE HYDROGEN SPIN EXCHANGE INTERACTION AND SPIN EXCHANGE CROSS SECTION WITH THE HYDROGEN MASER
Helmut W. Hellwig Oct. 1967 24 p refs
(ECOM-2892; AD-664154)

The report describes the theory and experiments leading to the quantitative determination of the hydrogen spin exchange interaction in an oscillating hydrogen maser, and to the measurement of the spin exchange cross section of the hydrogen atom. A value of delta = 2.65 x 10 to the -15th power cm sq. at room temperature is obtained and compared to previously published values. A concept for increasing the output power of the hydrogen maser is given. An improvement by a factor of 50 seems feasible, which would significantly increase the short-term stability of the hydrogen maser. Author (TAB)

N68-18431# Texas Univ., Austin. Labs. for Electronics and Related Science Research.
INVESTIGATION OF STRONG BLAST WAVES AND THE DYNAMICS OF LASER INDUCED PLASMAS IN HIGH PRESSURE GASES
Otto M. Friedrich, Jr., Frederic Weigl, and Arwin A. Dougal 1967 31 p refs Presented at the AIAA Joint Elec. Propulsion and Plasmadyn. Conf., Colorado Springs, 11–13 Sep. 1967 Sponsored in part by Tex. Atomic Energy Res. Found.
(Grant AF-AFOSR-766-67)
(AFOSR-68-0232; AD-664589)

Strong shocks produced when 2-3 joules of energy are released in high pressure gases by focusing a giant pulse laser are investigated analytically and experimentally. Strong blast wave theory is employed to calculate the position, velocity, maximum pressure, and temperature as functions of time and energy absorbed by the gas in the shocks formed for several gases at pressures of 1-2000 atmospheres. Experimentally, luminous fronts associated with strong blast waves produced in gases at pressures up to 2000 atmospheres with a focused 30 megawatt, 40 nanosecond pulse ruby laser are observed with Kerr cell photography. Optical interferometry with a Mach-Zehnder interferometer, absorption of a helium-neon laser beam, and piezoelectric pressure sensitive probe measurements of strong shocks produced in air at STP with a second, a 175 megawatt 17 nanosecond, giant pulse ruby laser show that during the rapid radial expansion of the shock, the measured position agrees to within 10% of that calculated. Relatively strong pressure fronts are observed at radii in excess of 50 cm and are spherical for radii larger than 2 cm. Author (TAB)

N68-18507*# Wolf Research and Development Corp., Bladensburg, Md. Applied Sciences Dept.
AN ANALYSIS OF THE GSFC LASER RANGING DATA
S. J. Moss and W. T. Wells 18 May 1967 72 p
(Contract NAS5-9756-58)
(NASA-CR-93411) CFSTI: HC $3.00/MF $0.65 CSCL 20E

Several sets of laser tracking data from the BE-C and GEOS-A satellites were analyzed, and attention is given to analytical and statistical techniques used to analyze data from a single highly accurate tracking system whose primary measurement is the slant

range from the tracker to the satellite. The differential correction process is discussed, including the orbit generator, the estimator, and the geometrical dilution of precision as related to tracking station data. Single-station range data results are presented; and deal with short arc orbital fit, systemmatic errors, and serial correlation. Doppler range rate and combined laser-doppler data are compared, and computation of time of observation, conversion of time interval to range, and first order refraction correction to range are discussed in terms of the pre-processing procedure. M.W.R.

N68-18860# Atomic Energy Commission, Oak Ridge, Tenn. Technical Information Div.
LASERS
Hal Hellman Jan. 1968 62 p refs
Available from USAEC, Oak Ridge, Tenn.

Background information on the electromagnetic spectrum, radio waves, light and the atom, coherent light, and controlled emission is presented to introduce the reader to the principles and concepts of lasers. A brief history of the laser is outlined followed by a discussion of its applications in such varied fields as holography, communications, surgery, and microwelding. The various kinds of lasers, including crystal, gas, and semiconductor lasers, are described and compared, and the concepts of pulsed and continuous wave laser operation and laser output are explained. The application and problems of using lasers for deep space communication are also discussed. R.N.A.

N68-18946*# Sylvania Electric Products, Inc., Mountain View, Calif. Western Div.
STABILIZED CO_2 GAS LASER Quarterly Report, 1 Jun.–1 Sep. 1967
1 Sep. 1967 34 p ref
(Contract NAS5-10309)
(NASA-CR-93546, QR-3) CFSTI: HC $3.00/MF $0.65 CSCL 20E

Testing and construction continued toward the development of a sealed-off, 20-watt, stabilized single-frequency CO_2 laser. Stability measurements on a 3-watt single-mode laser oscillator have shown frequency stabilities as high as 2 parts in 10^{10} (6 kHz) over 100 msec periods and 3 parts in 10^8 (1 MHz) over 30-minute periods. The design of a dc amplifier for use with the oscillator is presented which should provide about 10 dB of power gain. The design is also presented for the electrical console which will house the 20-watt laser power supplies and cooling system. Author

N68-19078*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
THE ANALYSIS OF TURBULENCE FROM DATA OBTAINED WITH A LASER VELOCIMETER
N. E. Welch and W. J. Tomme 5 Feb. 1968 32 p refs
(NASA-TM-X-53703) CFSTI: HC $3.00/MF $0.65 CSCL 20E

This investigation concerned the use of a laser velocimeter to determine point velocities in a turbulent liquid flowing in a pipe. The velocity distribution was determined at each point and for each rate of bulk flow. This method of measurement affords data unaffected by any proturberance into the flow stream. The frequency response of the base instrument and electronics is sufficient to measure all frequencies of turbulence investigated. The data was verified by comparing the mean velocity profile calculated from the probability distribution function with profiles determined by other methods of mean velocity measurement. The variance of the distribution function was verified with turbulent diffusion data. The velocity distribution function, as derived from statistical reasoning, was found to properly describe the measured axial velocity components. The change in the variance of the velocity distribution function is derived and is compared with the measured variance. Author

N68-19475 New Mexico State Univ., University Park.
OBSERVATIONS OF HOMOGENEOUS NUCLEATION AND DROPLET GROWTH IN A WILSON CLOUD CHAMBER BY MEANS OF LASER SCATTERING
Burton Gordon Schuster (Ph.D. Thesis) 1967 131 p
Available from Univ. Microfilms: HC $6.40/MF $3.00 Order No. 67-7385

Results are given of measurements of the optical extinction coefficient and relative differential cross section of water clouds in argon, produced in a Wilson cloud chamber at six values of expansion ratio, using a He–Ne laser for the source of incident radiation. A model is developed for the kinematics of droplet growth, used in conjunction with the classical and modified nucleation rate, for computation. The computed droplet size distribution is integrated against the appropriate optical scattering functions to produce theoretical cross sections, which are compared to the data. The classical nucleation rate appears to be too high for all expansion ratios except that which produces critical supersaturation. The empirically modified rate produces better agreement with the data. An accommodation coefficient of unity was used in the nucleation and growth rate equations, but the conclusion is that a coefficient of about 0.2 or 0.3 would improve the agreement between the theoretical and experimental results. Dissert. Abstr.

N68-19478# Helsinki Univ. (Finland). Dept. of Physics.
ON THE USE OF A RUBY LASER FOR EXCITING RAMAN SCATTERING FROM COLOURED POWDERS
Folke Stenman (Ph.D. Thesis) 1967 30 p refs Repr. from Commentationes Physico-Math., v. 33, no. 8, 1967

A study is made of different methods of illumination for obtaining Raman spectra from colored powders using ruby laser excitation. Raman scattering from twelve organic solids is investigated. Raman spectra are obtained from anthraquinone, anthrone, p-quinone, o-nitroaniline, benzil, azobenzene and phenolphtalein. Of these, only the p-quinone spectrum has been reported before in the solid state. For anthraquinone, anthrone and phenolphtalein, no certain Raman spectra at all have been reported before. The observed lines are assigned to specific molecular vibrations. The results are discussed and possible developments of the experimental methods are suggested and discussed. It is concluded that ruby lasers with a high repetition rate could bring about a major advance in this field of Raman spectroscopy. Author

17 MATERIALS, METALLIC

Includes cermets; corrosion; physical and mechanical properties of materials; metallurgy; and applications as structural materials. For basic research see: 06 Chemistry. For related information see also: 18 Materials, Nonmetallic; and 32 Structural Mechanics.

N68-18303# General Electric Co., Philadelphia, Pa. Missile and Space Div.
INVESTIGATION OF BONDING IN OXIDE-FIBER (WHISKER) REINFORCED METALS Progress Report, 18 Jul.–18 Oct. 1967
M. J. Noone and Willard H. Sutton Watertown, Mass. Army Mater. and Mech. Res. Center 18 Oct. 1967 29 p refs
(Contract DA-19-066-AMC-330(X))
(PR-6; AMMRC-CR-66-01/6; AD-664167)

The work is part of a continuing study to determine the effects of various additives on the wetting and bonding of nickel and nickel alloys to single crystal sapphire (alpha-Al2O3). The effects of bonding interactions at the surface of flame-polished sapphire rods on the subsequent strength of the rods are being

studied. Flame-polished rods with strength of 500000 to 800000 lb/sq in have been prepared and, with the exception of occasional large internal flows, the strength was related to surface smoothness. The majority of the time and effort expended in this period has been devoted to the development of the flame-polishing technique since the use of high-strength rods is critical to the performance of the experiments planned for this program. Preliminary heat treatments of rods sputtered with Ni-alloy coatings indicate that slight interactions can degrade the sapphire surface and significantly reduce the strength of the rods. TAB

N68-18342# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

SCIENCE OF AVIATION MATERIAL

A. E. Leykin, E. S. Porotskiy, and B. I. Rodin 16 Jun. 1967 478 p refs Transl. into ENGLISH of the book "Aviatsionnoye Materialovedeniye" Moscow, Mashgiz., 1964 p 1-459
(FTD-MT-65-270; AD-664567)

Basic characteristics of the most important metallic and nonmetallic materials applied in aviation constructions are considered. Given are methods of investigation of properties of alloys and also their inspection (defectoscopy), heat and chemical-heat treatment, and protection from corrosion. The report is a text for courses of the same name for students of technicums. It will also be useful for average technical staff of industry. Author (TAB)

N68-18368# Naval Research Lab., Washington, D. C.

THE EFFECTS OF AN AQUEOUS ENVIRONMENT ON THE FATIGUE CRACK PROPAGATION CHARACTERISTICS OF TITANIUM ALLOYS

T. W. Crooker and E. A. Lange 18 Sep. 1967 19 p refs
(NRL-6588; AD-664208)

Fatigue crack propagation was studied in Ti-6Al-4V, Ti-7Al-2Cb-1Ta, Ti-6Al-6V-2Sn-1Cu-0.5Fe, Ti-6Al-3V-1Mo, and Ti-7Al-2.5Mo alloys. These materials possess yield strengths in excess of 100 ksi, combined with favorable levels of fracture toughness, and they are currently under evaluation for application in large welded structures. Where an application involves repetitive loading, a knowledge of fatigue crack propagation characteristics is required for failure-safe design against fracture. Fabrication and non-destructive testing procedures cannot guarantee that cracklike defects, which can grow to a critical size, will not be present in plate-thickness sections containing welded joints. In addition, the role of an aggressive environment, such as salt water, in this failure mechanism is of the utmost importance. Fatigue crack propagation data were taken in both ambient room air and 3.5% salt-water environments. Surface-notched plate bend specimens were cycled in full-reverse (tension-to-compression) sinusoidal loading. The fatigue crack was observed optically, and the crack growth rate was described as an empirical power-law function of the total (elastic-plus-plastic) strain range. Fatigue crack growth rate relationships were first developed in an air environment and then employed as baselines for establishing the effect of the salt-water environment. Comparisons were made among the fatigue crack propagation characteristics of the several titanium alloys and among a broad spectrum of high-strength structural alloys, both ferrous and nonferrous, previously studied. Author (TAB)

N68-18394# Aerojet-General Corp., Sacramento, Calif. Materials Research Lab.

TERNARY PHASE EQUILIBRIA IN TRANSITION METAL-BORON-CARBON-SILICON SYSTEMS. PART 2: TERNARY SYSTEMS. VOLUME 17: CONSTITUTION OF TERNARY TA-MO-C ALLOYS

E. Rudy, St. Windisch, and C. E. Brukl Wright-Patterson AFB, Ohio AF Mater. Lab. Dec. 1967 102 p refs
(Contract AF 33(615)-1249)
(AFML-TR-65-2, Pt. 2, V. 17; AD-664344)

Phase equilibria in the ternary system vanadium-niobium-carbon from 800C through the melting ranges of the cubic monocarbide solid solutions were established on the basis of X-ray, melting point and metallographic studies. The phase equilibria above 1400C are presented in a three-dimensional temperature-composition constitutional diagram, since the phase equilibria below 1400C were not thoroughly investigated due to kinetic problems. Vanadium monocarbide and niobium monocarbide form a continuous series of solid solutions as do the low-temperature modification of the ordered hexagonal vanadium subcarbide to niobium subcarbide. However, the addition of vanadium subcarbide to niobium subcarbide stabilizes the high-temperature modification of the disordered hexagonal niobium subcarbide to about 1780C in the ternary field. Author (TAB)

N68-18415# Naval Research Lab., Washington, D. C.

THE TENSILE PROPERTIES OF SELECTED STEELS FOR USE IN NUCLEAR REACTOR PRESSURE VESSELS Final Report

Eugene P. Klier, J. R. Hawthorne, and Lendell E. Steele 26 Dec. 1967 59 p refs
(NRL-6649; AD-664460)

Seven steels now used or having potential for use in the construction of nuclear reactor containment vessels were evaluated in uniaxial tension at 75F following irradiation at <250F. Experiment irradiations involved neutron fluences up to 9.5 x 10 to the 19th power n/cm sq. (> 1Mev). Tensile properties of the A212-B, A302-B, A350-LF1 (Modified), A350-LF3, A353, T-1, and HY-80 (Ni-Cr-Mo) steels were determined as conventional tensile and yield strength and percent reduction of area. In addition, observed stress-strain relationships were plotted using both nominal stress-percent reduction of area coordinates and true stress-natural strain coordinates. Curves given in the latter coordinate system were also expressed in suitable analytic form. All individual tensile data were compiled in tabular form, and stress-strain curves were summarized as bands giving maximum and minimum properties behavior. Limited metallographic and fractographic data were obtained to establish the metallurgical structures of the steels and to depict the transition from a ductile shear fracture to a brittle flat fracture at high neutron fluences for the more brittle steels. Author (TAB)

N68-18419# ManLabs, Inc., Cambridge, Mass.

DEVELOPMENT AND APPLICATION OF METHODS FOR PREDICTING THE TEMPERATURE-COMPOSITION STABILITY OF REFRACTORY PHASES Technical Report, Jan.-Sep. 1967

Harold Bernstein and Larry Kaufman Wright-Patterson AFB, Ohio AF Mater. Lab. Dec. 1967 102 p refs
(Contract AF 33(615)-2352)
(AFML-TR-67-397; AD-664575)

Computer programs have been developed by generating ternary phase diagrams of frequency transition metals. Solutions for equilibria between liquid, bcc, hcp and fcc phases as well as miscibility gap formation in these phases are presented based upon the regular solution model. Interactions between these phases and Laves and AuCu3 type compounds are treated to compute the effect of compound intrusion on solution phase equilibria. This development can be applied to compute 286 ternary systems containing zirconium, hafnium, niobium, tantalum, molybdenum, tungsten, rhenium, ruthenium, osmium, rhodium, iridium, palladium and platinum. This development permits computation of the vapor pressure and vaporization rates of individual components and estimates of the heats of formation of ternary compound phases. Ternary sections in the Mo-W-Os, Zr-Ta-W, Re-W-Ta and Re-Hf-Mo systems at temperatures between 1800K and 3000K have been computed for comparison with the limited number of experimental ternary phase diagrams of refractory transition metals. Author (TAB)

N68-18421# Stanford Univ., Calif. Dept. of Materials Science.
THE MECHANICS OF CRACK ARREST IN MILD STEEL
T. R. Wilshaw and D. O. Harris Nov. 1967 16 p refs
(Contract DA-31-124-ARO(D)-251)
(SU-DMS-68-T-25; AROD-4800.10-MC; AD-664174)

Dynamic K sub IC values for mild steel were measured using instrumented impact bend tests containing fatigued notches and compared with the stress intensity values in a Robertson crack arrest test. It is proposed that crack arrest occurs by the initial slowing down of the crack due to increased temperature which leads to a dramatic deceleration due to the large strain-rate sensitivity of the material. When the strain rate at the crack tip is maintained by dynamic loading which causes forced crack propagation, the crack will remain brittle to much higher temperatures than the crack arrest temperature. Author (TAB)

N68-18533*# Battelle Memorial Inst., Columbus, Ohio.
HIGH TEMPERATURE DEFORMATION OF DISPERSION STRENGTHENED NICKEL ALLOYS. 1: THE INFLUENCE OF INITIAL STRUCTURE ON TENSILE AND CREEP DEFORMATION OF TD NICKEL. 2: THE EFFECT OF MATRIX STACKING FAULT ENERGY ON CREEP OF Ni-Cr-ThO_2 ALLOYS Final Report, 9 Feb. 1967–9 Feb. 1968
Ben A. Wilcox and A. H. Clauer 29 Feb. 1968 63 p refs
(Contract NAS3-9413)
(NASA-CR-72367) CFSTI: HC $3.00/MF $0.65 CSCL 11F

Tensile deformation studies on as-received and recrystallized TD Nickel were conducted over the temperature range 25–1200°C. Over the entire range, the yield strength of the recrystallized material was greater than that of pure polycrystalline nickel. A further yield strength increment was observed for the as-received TD Nickel bar over the whole range of test temperatures. These results are interpreted in terms of *direct* and *indirect* strengthening by the ThO_2 particles. High temperature creep studies showed that as-received TD Nickel was considerably stronger than the recrystallized material. In neither case, however, could the results be interpreted in terms of present creep theories. Author

N68-18549*# Massachusetts Inst. of Tech., Cambridge. Dept. of Metallurgy and Materials Science.
RESEARCH ON MECHANISMS OF ALLOY STRENGTHENING 1: ALLOY STRENGTHENING BY FINE OXIDE PARTICLE DISPERSION. 2: THE SPLAT COOLING PROCESS FOR ALLOY DEVELOPMENT Semiannual Report
Nicholas J. Grant Dec. 1967 29 p
(Grant NsG-117-61)
(NASA-CR-93409) CFSTI: HC $3.00/MF $0.65 CSCL 11F

Several experiments were conducted on oxide dispersed alloys in order to establish strengthening mechanisms, and to examine processing techniques for improving structural stability. The compositions of four Fe–BeO alloys are given, and figures depict the log stress versus log rupture time plots for various extrusions in the ferritic and austenitic temperature ranges. Consideration is also given to the sintered aluminum powder technique for oxide dispersion strengthened copper–Al_2O_3, and to a series of copper–aluminum alloys processed by internal oxidation following surface oxidation. The role of oxide contaminants and reactive metals in oxide dispersed alloys is assessed. Samples of Fe–BeO alloys produced by internal oxidation were subjected to a chromizing treatment by the halide process; results were considered better than those obtained on the iron–chromium–thoria alloy produced completely by the halide process. Deformation and fracture mode studies indicate that differences between oxide dispersed materials and conventional alloys are of degree, rather than of kind. Plans for alloy development based on the splat cooling process are outlined. M.G.J.

N68-18610*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
OXIDE DEFORMATION AND FIBER REINFORCEMENT IN A TUNGSTEN METAL OXIDE COMPOSITE
Charles P. Blankenship Washington Mar. 1968 41 p refs
(NASA-TN-D-4475) CFSTI: HC $3.00/MF $0.65 CSCL 11D

Refractory oxide particles of urania (UO_2) and zirconia (ZrO_2) were added to a tungsten matrix and elongated into fibers by hot extrusion. Extrusion temperatures ranged from 3200° to 4000°F (1760° to 2200°C). The geometry of the oxide fibers appeared to be closest to that of an ellipsoid with the major axis alined in the extrusion direction. Oxide fibering was measured by an average length-to-width ratio of the fibers sectioned parallel to the major axis. The extent of oxide deformation was estimated in terms of strain components. Oxide-matrix deformation characteristics were related to the extrusion parameters by comparing the estimated oxide strain components to those of the composite. Author

N68-18699# Atomic Energy of Canada, Ltd., Chalk River (Ontario).
MICROSTRUCTURES AND DISPERSOID MORPHOLOGY IN YTTRIA-ZIRCONIUM DISPERSIONS
B. G. Childs Oct. 1967 62 p refs
(AECL-2798) Available from Atomic Energy of Canada, Ltd., Chalk River: $1.50

Yttria-zirconium dispersions, examined at high magnification in the electron microscope, showed signs of chemical reaction between the two components which increased in extent with sintering time (1.5–12 h) and temperature (700–1200°C). The average particle diameter in dispersions having different sintering treatments varied between 0.087 and 0.412 μm and corresponding variations occurred in the average interparticle spacing. The yttria particles in the dispersions served to pin advancing grain boundaries and hence reduce the average grain size. Interaction was also observed between the particles and sub-boundaries (dislocation arrays) in hot rolled specimens; however, little or no interaction occurred between the particles and individual dislocations. In dispersions warm-rolled down to 50% reduction in thickness, a high particle density appeared to inhibit recovery and recrystallization during 5 hour anneals at 400°C and 600°C. Author

N68-18705# Iowa State Univ. of Science and Technology, Ames.
GROWING NICKEL SINGLE CRYSTALS BY PULLING FROM A MELT
James Herriott, Marlyn Murtha, and George Burnet Oct. 1967 15 p refs
(Contract W-7405-ENG-82)
(IS-1703) CFSTI: HC $3.00/MF $0.65

The Czochralski crystal pulling technique was used to grow single crystals of nickel. Crystals ranging in size from 0.06 in. diam and 0.5 in. long to 1.5 in. diam and 9.0 in. long were grown using a NRC crystal pulling unit. Details regarding the procedure used are reported. Author (NSA)

N68-18717# Garrett Corp., Los Angeles, Calif. AiResearch Manufacturing Div.
INVESTIGATION OF MATERIALS TO RESIST HOT CORROSION IN SMALL GAS TURBINE ENGINE RECUPERATORS Quarterly Report, 1 Sep.–30 Nov. 1967
G. Curbishley, O. Jones, and W. Larson Dec. 1967 24 p refs
(Contract DAAJ02-67-C-0048)
(HT-67-2512(2); QR-2; AD-664161)

The primary objective of the program was to select two braze alloys for use in brazing the four candidate tube materials into tube-to-header specimens. These specimens are for stress-rupture tests called for in Task D. All candidate tubing ordered during the initial stages of the program was received. Tube-to-header specimens were brazed and prepared for preliminary brazing tests. Brazing characteristics were recorded and are being evaluated by metallography. The 100-hr static hot corrosion test setup was built and the test has begun. Author (TAB)

N68-18735*# Toronto Univ. (Ontario). Inst. for Aerospace Studies.
STATISTICAL AND METALLOGRAPHIC ASPECTS OF FATIGUE FAILURE MECHANISMS IN METALS
R. Ravindran Feb. 1968 84 p refs Sponsored in part by NRC of Can.
(Grant NGR-52-026-008)
(NASA-CR-66578; UTIAS-TN-123) CFSTI: HC $3.00/MF $0.65 CSCL 11F

Copper specimens were tested at stress levels of 10.0 ksi, 16.5 ksi, and 19.0 ksi, and the results were analyzed using a single log-normal distribution, a single Weibull distribution, a truncated log-normal distribution, and the mathematical dissection method. Metallographic and X-ray examinations of the fatigued specimens were also carried out. The conclusions drawn include: (1) Both at the 16.5 ksi and the 19.0 ksi stress levels, a single log-normal distribution fitted the data better than a single Weibull distribution. (2) The truncation analysis did not indicate the existence of two distributions at these two stress levels. The mathematical dissection method showed the existence of only a single distribution which suggests that these two stress levels are above the bimodal transition region. (3) At 10.0 ksi, even though the life indicates that this stress level is in the low F range, there is some evidence of H range damage. (4) At 19.0 ksi there are about 60% H and 40% F range grains, thus indicating that there is no clear division between H and F. Author

N68-18766*# Alabama Univ., University. Bureau of Engineering Research.
A METHOD FOR CORRELATING ELEVATED TEMPERATURE FATIGUE DATA Final Report, Feb. 1961–Feb. 1962
Raymond M. Hollub Aug. 1962 152 p refs
(Contract NAS8-1517)
(NASA-CR-61631) CFSTI: HC $3.00/MF $0.65 CSCL 11F

The results of a research program to develop a method for correlating elevated temperature fatigue data is reported. Temperature parameter correlations are presented for 31 alloys at elevated temperatures and 7 alloys at low temperatures. The linear correlation is well demonstrated in the elevated and low temperature regions. Temperature ranges are included from 75°F to 1650°F and from 75°F to −423°F. The temperature correlation method is outlined for convenient application and a tabulation of elevated temperature fatigue data for approximately 250 alloys is presented. A comprehensive bibliography of references containing elevated temperature fatigue data is included. Author

N68-18874# Oak Ridge National Lab., Tenn. Metals and Ceramics Div.
CREEP-RUPTURE PROPERTIES OF UNALLOYED TANTALUM, Ta-10% W AND T-111 ALLOYS
R. L. Stephenson Dec. 1967 20 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-1994) CFSTI: HC $3.00/MF $0.65

The long-time, high-temperature creep properties of unalloyed tantalum, Ta-10% W, and T-111 (Ta-8% W–2% Hf) were studied at 1204, 1427, and 1649°C. The Ta-10% W and T-111 were much stronger than unalloyed tantalum. The properties of Ta-10% W and T-111 were almost equal for the thermomechanical histories studied. The ductilities of all three materials were excellent. Author (NSA)

N68-18999*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
USE OF SURFACE REPLICATION, EXTRACTION REPLICATION, AND THIN-FILM ELECTRON MICROSCOPY IN THE STUDY OF DISPERSION-STRENGTHENED MATERIALS
Charles A. Hoffman and Bruno C. Buzek Washington Mar. 1968 25 p refs
(NASA-TN-D-4461) CFSTI: HC $3.00/MF $0.65 CSCL 11F

An investigation was conducted on the relative merits of surface replication, extraction replication, and thin-film methods to evaluate the microstructures of dispersion-strengthened materials. Surface replication gave the best agreement of measured and nominal amounts of oxide whether the oxide was discrete and spheroidal ($Ni+ThO_2$) or plate-like and aggregated ($Al+Al_2O_3$); this method also gave the most satisfactory value of average particle size and average interparticle spacing. Extraction replication was also satisfactory for the former material but not for the latter; its validity was dependent on the shape of the oxide particles and its state of aggregation as well as the effectiveness of the extraction technique. The thin-film method was helpful in verifying the existence of the finer particles but gave considerably greater volume fractions of oxide particles compared to the respective nominal amounts. Particle-size–frequency distributions obtained from each of the three methods when applied to the $Ni+ThO_2$ essentially agreed. Stereoscopic, or three-dimensional, views of thin films gave better indication of the shape of the particles and the spatial relations between particles. Author

N68-19053# MSA Research Corp., Evans City, Pa.
LIMITED COMPARISON OF THE RELATIVE COMPARISON OF THE RELATIVE MERITS OF 304 VERSUS 316 STAINLESS STEEL FOR LIQUID METAL SERVICE Topical Report No. 10
R. C. Andrews, R. H. Hiltz, L. H. Kirschler, and R. J. Udavcak Dec. 1967 66 p
(Contract AT(11-1)-765)
(MSAR-67-216) CFSTI: HC $3.00/MF $0.65

A comparison is made of the relative merits of 304 versus 316 stainless steel for liquid metal service based on the limiting parameters of MSAR's AEC-sponsored material-test program and manufacturing experience. Results of metallurgical studies and mechanical property tests of material tested in air, helium, clean sodium, high-oxygen sodium, and high-carbon sodium are included. Photomicrographs, mechanical property strength, and design curves are also included as part of the comparison. The results of interviews with fabrication workers are discussed. Author (NSA)

N68-19073# Ohio State Univ. Research Foundation, Columbus.
A STUDY OF THE MECHANISM OF STRESS CORROSION CRACKING IN THE IRON-NICKEL-CHROMIUM ALLOY SYSTEM Quarterly Report, Mar. 17–Jun. 16, 1967
R. W. Staehle 10 Jul. 1967 57 p refs
(Contract AT(11-1)-1319)
(COO-1319-57(Q-16)) CFSTI: HC $3.00/MF $0.65

Additional analysis of effects of surface preparation on time-to-cracking in boiling $MgCl_2$ shows that the average time-to-breaking can be directly correlated with the potential-time behavior as measured on open circuit. Other analysis of the same data shows that the data fit log-normal distribution. Transient dissolution studies show that the breakdown of passivity by mechanically produced slip steps does not repassivate nearly as rapidly as chemically (addition of high chloride) broken passivity. Stress–strain studies of nickel single crystals showed that dissolution occurring simultaneously with flow lowers the yield point significantly compared with a flow curve determined in air. Results of thin foil examination continued to show the formation of slip step dissolution patterns in a wide variety of compositions. An extensive strain hardening study was completed and calculated values for the strain hardening parameters are reported. Author (NSA)

N68-19220*# IIT Research Inst., Chicago, Ill.
FABRICATION AND CHARACTERIZATION OF METAL CARBIDE-GRAPHITE COMPOSITES
Y. Harada and G. A. Rubin 9 May 1968 26 p Presented at the 68th Ann. Meeting of the Am. Ceram. Soc., Washington, 9 May 1968
(Contract NASr-65)
(NASA-CR-75184) CFSTI: HC $3.00/MF $0.65 CSCL 11F

Refractory metal carbide-graphite composites have been prepared by hot pressing and the effect of variation of composition and processing conditions on phase equilibration and physical properties such as flexural strength, hardness, thermal shock resistance, thermal expansion, and electrical resistivity has been studied. The systems investigated include TiC-C, ZrC-C, HfC-C, VC-C, NbC-C, TaC-C, MoC-C and WC-C. It has been found that the strength of all the composite materials investigated increased with increasing carbide content reaching a peak for the metal-carbide-graphite eutectic composition. An essentially linear relationship between electrical resistivity and flexural strength was found to be useful to calculate the strength level of the material and to understand the strengthening mechanism with increasing carbide content. Author

N68-19347*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EFFECT OF SURFACE ROUGHNESS ON THE 0.66-MICRON NORMAL SPECTRAL EMITTANCE OF VAPOR-DEPOSITED RHENIUM FROM 1500°K TO 2100°K
Peter Cipollone Washington Mar. 1968 20 p refs
(NASA-TM-X-1514) CFSTI: HC$3.00/MF$0.65 CSCL 20L

The normal spectral emittance of vapor-deposited rhenium at a 0.66-micron effective wavelength is presented, and the results are compared to previously published data on bar and sheet rhenium. A dependence of the normal spectral emittance on surface roughness is demonstrated quantitatively. Author

N68-19414# Royal Aircraft Establishment, Farnborough (England).
FACTORS AFFECTING EROSION IN A 12% CHROMIUM STEEL
D. J. Beckwith and J. B. Mariott *In its* Rain Erosion and Assoc. Phenomena Aug. 1967 p 233–235 refs (See N68-19401 09-13)

Water jet erosion tests and associated mechanical tests have been carried out on a stainless martensitic steel to determine the erosion resistance of the material and to examine the relationship between the erosion behavior and certain mechanical properties. Examination of the erosion curves shows that after the incubation period the rate of weight loss quickly reaches a maximum. When the incubation period in the erosion test is compared with the time required to propagate the fatigue crack in the same bar prior to fracture toughness testing, a correlation is obtained. The only exception to the relation is the 650°C tempered material. Metallographic examination of the surface of the steel specimens during incubation shows that they all exhibit a common behavior: there is deformation of the matrix and fine cracking. Most of the cracks tend to run along the martensite needle directions, through they can be associated with grain boundaries, inclusions, or other discontinuities. Author

N68-19416# Air Force Systems Command, Wright-Patterson AFB, Ohio. Nonmetallic Materials Div.
ELECTROPLATED NICKEL RAIN EROSION RESISTANT COATING
James H. Weaver *In* RAE Rain Erosion and Assoc. Phenomena Aug. 1967 p 247–259 refs (See N68-19401 09-13)

Approaches summarized in this research effort are an attempt to improve the protective capabilities of plated metallic coatings for rain erosion protection for advanced aircraft systems. Epoxy, polyester, and polybenzimidazole laminated were electroplated with a minimum of 12 mil of nickel and exposed to rain environment at subsonic speeds. The coated epoxy endured 160 minutes, the plated polyester 180 minutes, and the plated polybenzimidazole 473 minutes with no visible evidence of erosion. This represents a 40-fold increase in resistance over specification neoprene coatings. Supersonic rocket sled test runs at Mach 1.5 and 2.0 showed no evidence of erosion. The 60° angle exposure at Mach 2.5 showed mild damage. Electroformed nickel patches were bonded to stabilizer edges of an F-100 airplane and the plane made a total of 163 penetrations into rain and hail storms for a total time of 440 minutes in storms with no indication of erosion of the electroformed nickel. Substrate preparation and nickel thickness were found to be most important criteria for obtaining good rain erosion resistant coatings. Mechanical interlocking achieved by sandblasting appears to be the most efficient method to obtain adhesion to the inert surface. Author

N68-19421# Royal Aircraft Establishment, Farnborough (England).
RAIN EROSION BEHAVIOR OF GALVANIZED COATINGS [REGENEROSIONSVERHALTEN GALVANISCHER SCHICHTEN]
E. Steinebach *In its* Rain Erosion and Assoc. Phenomena Aug. 1967 p 334–339 refs In GERMAN (See N68-19401 09-13)

The rain impact erosion behavior of galvanic nickel and chromium layers on steel structures was evaluated by: (1) density measurements on the hardening nickel layers; (2) strength variations of the nickel coated austenitic steel; (3) pretreatment effects on the bonding strength of aluminum layers on steel; (4) determining the effects of protective layer thicknesses. Rain impact damage tests showed a pronounced correlation between protective layer hardness, inner structural strain, and strength of the substrate material with the layer thickness and pretreatment processes for improved bonding. The author concludes that galvanic surface layers are feasible for supersonic aircraft structure coatings. Transl. by G.G.

N68-19424# Royal Aircraft Establishment, Farnborough (England).
RAIN DROP IMPACT BEHAVIOR IN IRON AND ANNEALED STEEL [TROPFENSCHLAGVERHALTEN VON EISEN UND VERGUETETEN STAEHLEN]
W. Herbert *In its* Rain Erosion and Assoc. Phenomena Aug. 1967 p 380–398 refs In GERMAN (See N68-19401 09-13)

The effects of water erosion on turbine blade materials was evaluated for various steel combinations. Droplet impact tests at differing velocities and angles of attack showed that nitrated and martensitic steels are necessary to withstand erosion damage. Caromium steels exhibited the best resistance properties. Layers of tungsten carbide provided steel structures with stable and even erosion resistance. Transl. by G.G.

N68-19481# Naval Research Lab., Washington, D. C.
REPORT OF NRL PROGRESS
R. W. Huber, R. J. Goode, and R. W. Judy Nov. 1967 54 p
(PB-176490) CFSTI: HC$3.00/MF$0.65

Complete article: Fracture toughness and stress-corrosion cracking of some titanium alloy weldments. Summaries are given of research in the following fields: chemistry, electricity, mechanics, metallurgy and ceramics, radio, solid state physics, and sound. TAB

18 MATERIALS, NONMETALLIC

Includes corrosion; physical and mechanical properties of materials (e.g., plastics); and elastomers, hydraulic fluids, etc. For basic research see: 06 Chemistry. For related information see also: 17 Materials, Metallic; 27 Propellants; and 32 Structural Mechanics.

N68-18277# Rock Island Arsenal Lab., Ill. Research and Engineering Div.
ENVIRONMENTAL STABILITY OF PAPER PRODUCTS
William F. Garland Nov. 1967 26 p refs
(RIA-67-2833; AD-664136)

The study covers the investigation of some fifteen paper additives (including oxidized and cationic starches, neoprene and urethane lattices, a water soluble polymer, a fluorocarbon resin and aqueous and nonaqueous fungicides) for possible use in upgrading kraft type paper. It was desired to improve oil, water, aging and fungus resistance properties of the paper. Author (TAB)

N68-18343# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

RESIDUAL OILS OF HIGHER VISCOSITY [OSTATOCHNYYE MASLA POVYSHENNOY VYAZKOSTI]

P. A. Zolotarev 18 Aug. 1967 11 p refs Transl. into ENGLISH from Neftepererabotka i Neftekhim., Nauchn.-Tekhn. Sb. (Moscow), no. 5, 1965 p 3–6

(FTD-HT-66-578; AD-664075)

A new method for the processing of asphalt flux into high-viscosity oils was developed in the process of investigating the intermediate phase removal from an asphalt-elimination assembly. Under the working conditions, the light phase of highly viscous oils in the propane solution was formed due to the temperature difference in the propane feed zone and in the lower part of the extraction tower and to the introduction of fresh solvent under the level of the asphalt phase. The light phase was drained off continuously into the solvent regenerating system, where the convection coil of the tubular heater was installed. The lateral flow was directed through the convestion part of the heater into the propane evaporizer, from which the propane vapors proceeded into a condenser while the residual solvent was steamed in the stripper. Propane and water vapors formed in the upper part of the stripper were let out into the blender, while the highly viscous oil was drained off by a special pump and was purified by phenol. Paraffin elimination was accomplished in two stages. TAB

N68-18402# General Precision, Inc., Little Falls, N. J. Aerospace Research Center.

STUDY OF MICROMECHANICAL PROPERTIES OF ADHESIVE BONDED JOINTS Quarterly Progress Report, 1 Oct.–31 Dec. 1967

Michael C. Franzblau and John L. Rutherford 15 Jan. 1968 43 p refs

(Contract DAAA21-67-C-0500)

(QPR-2; AD-664170) CFSTI: HC $3.00/MF $0.65

The second quarterly report gives a program to measure the mechanical properties of adhesive bonded joints, utilizing advanced high precision microstrain techniques. During the current report period, progress was noted as follows: (1) The tensile behavior of Epon 9601, a sheet adhesive, was investigated for several sheet thicknesses. The deformation was found to be viscoelastic and the dielectric constant was strain sensitive. (2) The effect of temperature on the tensile properties of Epon 9601 was studied in the temperature range -10 to 200F. The effective tensile modulus increased at low temperatures and the deformation became elastic. At elevated temperatures, plastic flow was observed at low stresses. (3) Tensile tests were made with the Epon 828/Versamid 140 system using aluminum adherends instead of stainless steel. This change resulted in higher fracture stresses and cohesive failure as opposed to adhesive failure for the stainless steel. (4) The shear moduli and fracture stresses of several thicknesses Epon 9601 were measured using the napkin ring torsion apparatus. (5) The dependence of the effective tensile modulus on joint thickness for the system Epon 828/Versamid 140 is explained on the basis of a layered structure within the joint, which influences its mechanical properties. Author (TAB)

N68-18504*# General Precision, Inc., Little Falls, N. J. Aerospace Research Center.

HIGH TEMPERATURE STABLE CARBORANE ADHESIVES Quarterly Progress Report, 21 Jun.–20 Sep. 1968

Robert Barnes 15 Oct. 1968 24 p refs

(Contract NAS9-5527)

(NASA-CR-65990; QPR-3) CFSTI: HC $3.00/MF $0.65 CSCL 11A

Synthesis and evaluation of carborane-epoxy adhesives were considered for high temperature aerospace applications. Mono(epoxybutyl)carborane was prepared, and a total of 7.9 gm was obtained in one batch using a scaled-up procedure. A total of 6.6 gm of bis(epoxybutyl)carborane was obtained in two batches. Alkenylcarborane intermediates were also synthesized. An adhesive bond property evaluation was made using both the mono-variety and bis(epoxybutyl)carborane, and the polymerization of these compounds was also studied. The most promising systems observed were generated with boron trifluoride monethylamine as the catalyst. M.W.R.

N68-18535*# TRW Systems, Redondo Beach, Calif.

INVESTIGATION OF RESIN SYSTEMS FOR IMPROVED ABLATIVE MATERIALS Interim Report, 10 Jan.–1 Jul. 1968

E. A. Burns, H. R. Lubowitz, J. F. Jones, and R. C. Nordberg 25 Jul. 1968 127 p refs

(Contract NAS3-7949)

(NASA-CR-72022; TRW-4550-6007-R0000) CFSTI: HC $3.00/MF $0.65 CSCL 11I

Material development tasks initiated during this period involved synthesis and property determinations, resin formulation optimization and composite processing parameter studies. Synthesis and property determinations have been directed to preparation and evaluation of new modified polyimide resins based on new anhydride monomers, bis(5-tetrahydrophthalic anhydride) sulfone and bis(p-3,4-dicarbosy anhydride phenoxy phenyl) sulfone, which offer improved processability. Composite processing studies have been conducted to determine the parameters which affect the fabrication of graphite and silica reinforced polyamide-imide and modified polyimide resins. Preliminary testing of the resistance of neat resins and composites containing state-of-the-art and advanced resins in fluorine/hydrogen and FLOX/methane combustion environments shows that (1) "stiff" polymers appear to be superior to other types of organic resins, and (2) different reinforcements are preferred in each propellant combination combustion environment—graphite in fluorine/hydrogen and silica in FLOX/methane. Author

N68-18849*# International Business Machines Corp., Cambridge, Mass.

INVESTIGATION OF REFRACTORY DIELECTRICS FOR INTEGRATED CIRCUITS

V. Y. Doo and D. R. Kerr Washington NASA Mar. 1968 81 p refs

(Contract NAS12-105)

(NASA-CR-995) CFSTI: HC $3.00/MF $0.65 CSCL 20L

Growth parameters for pyrolytic silicon nitride such as nucleation, reactant composition, substrate temperature, substrate preparation, and carrier gas were studied. Measurements were made in MNS (metal-nitride-silicon) and MNOS (metal-nitride-oxide-silicon) samples for surface charge density, electronic leakage and dielectric constant determination. The index of refraction and 48% HF etch rate were also measured. The masking property of silicon nitride for dopants which silicon dioxide fails to mask was investigated. Photolithographic techniques were developed so that conventional photoresist could be used. Silicon nitride together with silicon dioxide was used to passivate silicon integrated circuit transistors and diodes. The integrated circuits were thermally and electrically stressed, and the results on H_{FB} and junction breakdowns changes were recorded. Author

N68-19060# Royal Aircraft Establishment, Farnborough (England).
THE INFLUENCE OF THE SEQUENCE LENGTH DISTRIBUTION ON THE UPPER MELTING RANGE OF COPOLYMERS [EINFLUSS DER SEQUENZLANGENVERTIELUNG AUF DAS SCHMELZ-ENDE VON COPOLYMEREN]
H. Baur Nov. 1967 11 p refs Transl. into ENGLISH from Makromol. Chem. (Heidelberg), v. 98, 1966 297–300
(RAE-LIB-TRANS-1263) CFSTI: HC $3.00/MF $0.65

A theory of the melting of copolymers is developed from a model of the copolymer melt as a mixture of sequences of units of the two comonomers, and the influence of sequence length distribution on the upper melting range of copolymers is discussed. Theoretical predictions of the variation of melting point with copolymer composition are compared with experimental data for copolymers of ethylene with propylene, butene, and pentene respectively. Author

N68-19173# Wayne State Univ., Detroit, Mich. Dept. of Chemistry.
CONTROLLED POLYMERIZATION OF ADSORBED MONOMERS Technical Progress Report
H. K. Livingston 27 Dec. 1967 28 p refs
(Contract AT(11-1)-1580)
(COO-1580-3) CFSTI: HC $3.00/MF $0.65

The state of the art of adsorption polymerization is reviewed. The irradiation of furam molecules adsorbed on graphitized carbon black is described. A Langmuir surface balance for studying insoluble monolayers on water was used to prepare built-up monolayers of a polymerizable long-chain acid. (49 references). NSA

N68-19272# Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
RADIATION-INDUCED GRAFT COPOLYMERIZATION OF STYRENE WITH POLYESTER FOIL AND CORD [RADIACYJNE SZCZEPIENIE STYRENU NA FOLII ORAZ KORDZIE Z POLITEREFTALANU ETYLENOWEGO]
Zofia Bulhak and Waclaw Zielinski 1967 16 p refs In POLISH; ENGLISH summary
(INR-841/17/C) CFSTI: HC $3.00/MF $0.65

Graft-copolymerization of styrene with commercially available cord and polyester foil was achieved using radiation technique. Afterwards strength and adhesive properties of copolymers were estimated. The influence of temperature, solvents concentration and absorbed dose on the effectiveness of the grafting were determined. Modified cord exhibits a few decrease of its strength properties but a small increase of adhesiveness to the rubber. Author

N68-19402# SAAB Aircraft Co., Linkoping (Sweden).
DESIGN RULES FOR NEOPRENE COATINGS
Sven Eskilsson *In* RAE Rain Erosion and Assoc. Phenomena Aug. 1967 p 1–10 (See N68-19401 09-13)

At the first Meersburg Conference on rain erosion a description was made of the Saab neoprene coating technique, the rotating arm test rig and some test results, such as the dependency of impact angle and speed of the rain erosion effects on flat specimens of glass fabric polyester laminates with neoprene coatings. The research has now been completed at higher speeds with different neoprene thicknesses and a diagram has been made from which it is possible to design for a specified erosion time at different speeds, surface angles of attack and neoprene thicknesses. Author

N68-19411# Royal Aircraft Establishment, Farnborough (England).
POLYURETHANE COATINGS FOR RAIN EROSION PROTECTION
George F. Schmitt, Jr. *In its* Rain Erosion and Assoc. Phenomena Aug. 1967 p 191–210 refs (See N68-19401 09-13)

Advancements in polyurethane coatings for subsonic rain erosion protection of metallic and plastic laminate substrates are described. Polyurethane coatings have been developed which offer protection for up to 2 hours at 500 mph in 2 inches per hour simulated rainfall on a whirling arm apparatus; by comparison the specification neoprene coating lasts 5 to 8 minutes under the same conditions. Flight tests on an F-100 aircraft and a UH-1 helicopter flying in heavy rain have confirmed the protectiveness of the coatings. Experimental studies of polyurethanes have indicated that a low modulus vehicle with good tensile strength and elongation yields the most erosion resistant coatings. Whirling arm evaluations, S.S. White abrasion data, and hysteresis measurements have proven vital in determining these factors. Microwave power transmission tests have indicated 94 to 96 percent transmission for polyurethane coatings as compared to 90 percent for the neoprene coatings. Author

N68-19415# Royal Aircraft Establishment, Farnborough (England).
THE UNITED STATES AIR FORCE–NAVY SUPERSONIC RAIN EROSION PROGRAM FOR 1966
George J. Tatnall, Kenneth W. Foulke, and George F. Schmitt *In its* Rain Erosion and Assoc. Phenomena Aug. 1967 p 236–246 ref (See N68-19401 09-13)

Test and data evaluation methods for rain erosion effects on brittle and plastic dielectric materials, coatings, composites, and several ductile metals are described. Results from numerous rocket sled firings with rainfield velocities between Mach 1.5 and 3.0 and at various angles of attack, showed that a Furane epoxy laminate was more resistant than the other thermal plastics tested. Teflon eroded at a very uniform rate and proved less resistant than Plexiglass, but more resistant than the fused silica. The best grade of aluminum oxide exhibited no measureble damage or weight loss even at the highest angles and velocities. Other ceramics exhibited resistances between the two extremes of alumina and fused silica. All glass materials were very succeptible to water erosion, but several new ceramic-plastic composites and thermal plastic materials showed improvement over previously used materials and coatings. G.G.

N68-19420# Royal Aircraft Establishment, Farnborough (England).
RAIN EROSION OF CERAMICS AT HIGH MACH NUMBERS
J. D. Walton, Jr. and C. W. Gorton *In its* Rain Erosion and Assoc. Phenomena Aug. 1967 p 310–333 refs (See N68-19401 09-13)

Theoretical calculations, and a proposed rain erosion sled test program for slip-cast fused silica are discussed in order to determine the relationship between the mechanical properties of materials and their resistance to rain erosion. Rain erosion resistance data of Al_2O_3 ceramics previously obtained were analyzed for transverse strength, grain size, and density and from this evaluation the rain erosion behavior of slip-cast fused silica and the compressive strength of this material were deduced. It was not possible to predict the rain erosion behavior of a particular ceramic material by this method. G.G.

N68-19422# Mithras, Inc., Cambridge, Mass.
DROP BREAKUP BY AIRSTREAM IMPACT
James E. Nicholson *In* RAE Rain Erosion and Assoc. Phenomena Aug. 1967 p 342–369 refs (See N68-19401 09-13)
(Contract Nonr-3684(00))

The effects of an impulsively applied airstream on the breakup of a water droplet are examined analytically and experimentally. Scaling laws for droplet breakup are derived in which the time to diminish a droplet to a critical size is related to the impact pressure, q2. The drop breakup relation is obtained, $tb/d = k/q2^{1/2}$, where the value of the constant k is to be determined from experiment. This relationship is valid when the value of the Weber number is much larger than one. A shocktube experiment is described in which detailed photographs of drop motion and breakup are obtained with a high speed framing camera. Drop displacement and breakup data

are obtained over a range of shock front Mach number from 1.85 to 2.84; simultaneously impact pressure is varied from 2.67 to 28.4 psi. The value of the drop breakup constant is determined to be, $K = 23.0$ ms-psi$^{1/2}$ in. Author

19 MATHEMATICS

Includes calculation methods and theory; and numerical analysis. For applications see: 08 Computers.

N68-18257# Washington Univ., Seattle. Dept. of Psychology.
GENERALIZED SCALE-FREE MATRIX APPROXIMATION WITH VARIABLE LOSS FUNCTION
Paul Horst Jan. 1968 16 p refs
(Contract Nonr-477(33); Grant PHS-G-MH-00743-12)
(AD-664506)

A rationale is developed for least square generalized scale free matrix approximation with variable loss function. A computing algorithm is provided which appears to give results close to the theoretical least square criterion. Special cases of the general case are identified as previously developed factor analytic techniques. The method is applied to seven sets of experimental data. Author (TAB)

N68-18265# RAND Corp., Santa Monica, Calif.
A QUEUEING REWARD SYSTEM WITH SEVERAL CUSTOMER CLASSES
Bruce L. Miller Jan. 1968 25 p refs
(Grant NSF GP-3739)
(P-3772; AD-664562)

The paper considers an n-server queueing system with m customer classes distinguished by the reward associated with serving customers of that class. Our objective is to accept or reject customers so as to maximize the expected value of the rewards received over an infinite planning horizon. By making the assumptions of Poisson arrivals and a common exponential service time this problem can be formulated as an infinite horizon continuous time Markov decision problem. In Section 3 we customize the general algorithm for solving continuous time Markov decision problems to our queueing model. In Section 4 we obtain qualitative results about the form of the optimal policy. Section 6 reports the results of simulation tests which compare heuristic policies for our model when the service times associated with each customer class have arbitrary distributions. The winning policy is based on a rather intricate theorem whose proof comprises Section 5. Author (TAB)

N68-18267# Syracuse Univ., N. Y.
FUNCTIONS OF A MATRIX
F. M. Reza Griffiss AFB, N. Y. RADC Nov. 1967 93 p refs
(Contract AF 30(602)-3852)
(RADC-TR-67-376; AD-663739)

This is an expository report consisting of two chapters. Chapter one contains some pertinent background material on Matrix Theory. This includes topics such as the norm of a matrix compatible with the norm of the signal space and other review materials. Chapter two deals with the problem of canonical representation of linear operators in finite-dimensional spaces. The Jordon canonical form is discussed in some detail. Several methods for the important problem of the evaluation of a function of a matrix are presented. The method of constituent, the theory of invariant factors, gamma-matrix, eigenvalue problems, and Cauchys integral of a matrix are among the subjects treated here. Author (TAB)

N68-18283# Weibull (Waloddi), Lausanne (Switzerland).
MOMENTS ABOUT SMALLEST SAMPLE VALUE Technical Report, Apr. 1965–Apr. 1966
Waloddi Weibull Dec. 1967 35 p refs
(Contract AF 61(052)-522)
(AFML-TR-67-375; AD-664049) CFSTI: HC $3.00/MF $0.65

A new type of moments has been achieved by substituting in the central moments the smallest value of the sample for its mean. The new moments have the same advantage as the central moments of being independent of the location parameter but for certain value of the shape parameter they have less variance and thus are preferable for estimating purposes. The asymptotic properties of four estimators, three of them composed of the new moments and one of them of central moments have been examined. It could be concluded that for the shape parameter alpha = or is > 0.5 the estimator, which was composed of the first and second order moments of the new type, was by far the most efficient one. Small-sample properties of the new-moments estimators have been appraised by use of extensive Monte-Carlo studies and it could be stated that the same conclusion applies also to small and moderate sample sizes. Author (TAB)

N68-18347# RAND Corp., Santa Monica, Calif.
A ZERO-ONE PROGRAMMING APPROACH TO SCHEDULING WITH LIMITED RESOURCES
A. A. B. Pritsker and L. J. Watters Jan. 1968 94 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5561-PR; AD-664551)

A zero-one linear programming formulation of scheduling problems that is more versatile and efficient than any other known LP formulation. It is the first formulation designed to accommodate multiple resource constraints. Bowmans formulation can be extended to do so, but in a sample comparison, it required 72 variables and 125 constraints for a 3-project, 8-job, 3-resource problem compared with 33 variables and 48 constraints for the new formulation. The new method also showed substantial improvement when compared with schedules based on two common dispatching rules: first-come-first-served and earliest-completion-date. Execution time on an IBM 7044, using the Geoffrion computer code, was 3 seconds. Other objective functions are formulated in the study and additional constraints are modeled. Examples of larger problems rewritten for standard LP computer codes showed that the number of variables and constraints involved are probably within no more than one order-of-magnitude of the maximum number that could be handled with available zero-one computer codes. Author (TAB)

N68-18348# RAND Corp., Santa Monica, Calif.
DERIVATION AND VALIDATION OF AN INITIAL-VALUE METHOD FOR CERTAIN NONLINEAR TWO-POINT BOUNDARY-VALUE PROBLEMS
H. H. Kagiwada and R. E. Kalaba Jan. 1968 38 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5566-PR; AD-664550)

Much of the theory of invariant imbedding is devoted to the conversion of boundary-value problems into initial-value (Cauchy) problems because of the computational advantages offered by the initial-value formulation. This study describes a technique for transforming a nonlinear two-point boundary-value problem into an initial-value problem and shows, conversely, that the solution of the Cauchy problem does satisfy the original boundary-value problem. The technique given is broad enough to cover many of the equations of radiative transfer, dilute gas dynamics, and optimal control. Author (TAB)

N68-18357# Research Analysis Corp., McLean, Va.
LIFE DISTRIBUTIONS DERIVED FROM STOCHASTIC HAZARD FUNCTIONS

Carl M. Harris and Nozer D. Singpurwalla (Western Elec. Co., Inc.) Oct. 1967 35 p refs
(Contract DA-44-188-ARO-1)
(RAC-TP-280; AD-664142) CFSTI: HC $3.00/MF $0.65

Most of the familiar time-to-failure distributions used today are derived from hazard functions whose parameters are assumed to be constant. In this paper an unconditional time-to-failure distribution is derived by assuming that a parameter of a classical failure distribution (viz, exponential and Weibull) is a random variable with a known distribution. With the use of the derived compound distributions and Bayesian techniques, it is then possible to join the test data with prior information to arrive at a combined, and possibly superior, estimate of reliability. The prior distributions considered here are the two-point, the uniform, and the gamma. Conceptually such a scheme may be a more realistic model for describing failure patterns under specific conditions. Author (TAB)

N68-18397# Michigan Univ., Ann Arbor. Dept. of Communication Sciences.
A CLASS OF SEQUENTIAL SAMPLING PROBLEMS ARISING IN CERTAIN LEARNING SITUATIONS
Edwin S. Bainbridge Dec. 1967 18 p
(Contracts DA-31-124-ARO(D)-483; Nonr-1224(21); Grant NIH G-GM-12236-04)
(TR-03105-49-T; AD-664144)

A strategist is to decide on each of n turns whether to take a sample from a certain fixed random variable, and receive the outcome as payoff, or to receive as payoff the largest value of the random variable he has discovered so far. The expected total payoff for the n turns is to be maximized. It is shown that the following decision procedure is the solution. x prime is the current record value, and F(x) is the distribution function of the random variable. A strategy for an indefinite number of turns is described, and for suitable distributions it is shown that the limit of the ratio of the payoff accumulated by this strategy in n turns to the payoff accumulated by the optimal strategy for n turns in one, with probability one. Author (TAB)

N68-18412# Stanford Univ., Calif.
ARBITRARY STATE MARKOVIAN DECISION PROCESSES
Sheldon M. Ross 8 Jan. 1968 16 p refs
(Contract Nonr-225(53))
(TR-105; AD-664459) CFSTI: HC $3.00/MF $0.65

Arbitrary state, finite action Markovian decision processes are studied with respect to the (long-run) average cost criterion. The problem is treated both as a limiting case of the discounted cost problem and also as a limit of the n-stage problem. Sufficient conditions are given for the existence of an optimal rule and for it to be of stationary deterministic type. Author (TAB)

N68-18413# Stanford Univ., Calif.
MULTIPRODUCT INVENTORY MODELS WITH SET-UP
Alan Wheeler 12 Jan. 1968 141 p refs
(Contract Nonr-225(53))
(TR-106; AD-664457) CFSTI: HC $3.00/MF $0.65

The report presents a mathematical model of an inventory problem frequently encountered in practice and studies the nature of the best ordering policy to use for it. At the beginning of each of a sequence of periods an inventory manager must decide whether or not to place an order and, if so, how much of which products. His order is filled immediately and then during the period a random demand draws upon his inventory until at the beginning of the next period he makes another ordering decision. When he orders, a unit cost for each item and a set-up cost for the order are charged. The set-up cost is thus independent of the size of the order and may represent the price of such things as paperwork, tooling up for a production run, or construction of facilities. On the basis of the inventory levels at the end of a period an inventory cost is charged. This represents a holding cost for those products still in stock and a penalty cost for those whose supply is depleted. Since the actual demand is not known but random, the inventory manager does not have full control over the costs he will be charged. It is assumed, however, that he can obtain his expected costs by averaging over the random demands, and his aim then is to use an ordering policy which minimizes his expected costs. As the mathematical inventory literature is quite large it is important to emphasize four distinctive features of the model in this report: periodic review, random demand, set-up costs, and interdependence of product costs. The present study is the most general one known by the author to combine all four attributes. TAB

N68-18417# Stanford Univ., Calif.
A MARKOV DECISION PROCESS WITH COSTLY INSPECTION
Stephen M. Tafeen 15 Jan. 1968 51 p refs
(Contract Nonr-225(53))
(TR-107; AD-664456)

A simple production process which has only two states in which production is possible, and two other states in which no production can take place is studied. The items produced are classified as either acceptable or defective. Costs are associated with producing defective items, inspecting items and repairing the process. Immediately after repair, and only then, is the process state known. An optimal control rule, which tells when to inspect items and when to repair the machinery, based on the past history of the process is sought. The problem in which inspection costs are nil, and hence 100% inspection is used, has been studied by Girshick and Rubin. When the process satisfies certain conditions, an optimal control rule is characterized, and a method for obtaining the rule is presented. Several other methods are given which produce almost optimal solutions when these conditions are violated. Author (TAB)

N68-18418# Rocketdyne, Canoga Park, Calif.
SMALL INCOMPLETE FACTORIAL EXPERIMENT DESIGNS FOR TWO AND THREE LEVEL FACTORS
Steve R. Webb Wright-Patterson AFB, Ohio ARL Feb. 1967 48 p refs
(Contract AF 33(615)-2818)
(ARL-67-0022; AD-664573)

A number of new small incomplete factorial designs are given for two- and three-level factors. It is assumed that the three-level factors are quantitative. The designs are suitable for estimating a selection of interactions, including the linear-by-linear components of interactions between the three-level factors. Ad hoc methods were used to construct the designs, so that there is no particular uniformity in the designs and no general property of optimality which they satisfy. Designs were selected on the basis of a measure of efficiency which is presented. No claim is made that the given designs are the best possible, and others should be encouraged to try to develop more efficient designs. A detailed example based on a real experiment is presented. Author (TAB)

N68-18445# Purdue Univ., Lafayette, Ind. Dept. of Statistics.
A GENERALIZATION OF BERNSTEIN'S THEOREM AND A DIFFERENTIAL INVERSION FORMULA
William J. Studden Dec. 1967 27 p refs *Its* Mimeograph Ser. No. 134
(Contract Nonr-1100(26))
(AD-664473)

A function phi(t) is called completely momotone (CM) on (o, infinity) if (-1) raised to the nth power phi(t) = or > o, n = 0, 1,... and t > o. Bernsteins theorem states that a function phi is CM if and only if phi is the Laplace transform of a measure on (o, infinity). Moreover the generating measure can be obtained from phi by applying a sequence of differential operators to phi. These

two results are generalized to the case where (-1) raised to the nth power phi(t) = or > 0. n = 0,1,... is replaced by an infinite sequence of differential inequalities of a special type.
Author (TAB)

N68-18449# Stanford Univ., Calif. Dept. of Computer Science.
ITERATIVE REFINEMENTS OF LINEAR LEAST SQUARES SOLUTIONS BY HOUSEHOLDER TRANSFORMATIONS
Ake Bjoerck and Gene Golub 19 Jan. 1968 35 p refs
(Contract Nonr-225(37))
(SU-CS-83; AD-664237)

An algorithm is presented in ALGOL for iteratively refining the solution to a linear least squares problem with linear constraints. Numerical results presented show that a high degree of accuracy is obtained.
Author (TAB)

N68-18454# Purdue Univ., Lafayette, Ind. Dept. of Statistics.
ON THE DISTRIBUTION OF THE MAXIMUM AND MINIMUM OF RATIOS OF ORDER STATISTICS
R. E. Barlow, S. S. Gupta, and S. Panchapakesan Dec. 1967 21 p refs *Its* Mimeograph Ser. No. 133 Prepared in cooperation with California Univ.
(Contracts Nonr-1100(26); Nonr-3656(18); F33615-67-C-1244)
(AD-664475)

Let X sub i(i = 0,1,...,p) be (p + 1) independent and identically distributed nonnegative random variables each representing the jth order statistic in a random sample of size n from a continuous distribution G(x) of a nonnegative random variable. Let H sub (j,n) (x) be the cumulative distribution function of X sub i(i = 0,1,...,p). Consider the ratios Y sub i = X sub i/X sub o (i = 1,2,...,p). The random variables Y sub i (i = 1,2,...,p) are correlated and the distribution of the maximum and the minimum is of interest in problems of selection and ranking for restricted families of distribution. The distribution-free subset selection rules using the percentage points of these order statistics are investigated in a companion paper by Barlow and Gupta (1967). In the present paper, we discuss the distribution of these statistics, in general, for any G(x) and then derive specific results for G(x) = 1-(e to the power (-x/theta)), x > 0, theta > 0. Section 2 deals with the distribution of the maximum while Section 3 discusses the distribution of the minimum. Section 4 describes the tables of the percentage points of the two statistics.
Author (TAB)

N68-18455*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
PLANCK FUNCTIONS AND INTEGRALS—METHODS OF COMPUTATION
Thomas E. Michels Mar. 1968 39 p refs
(NASA-TN-D-4446) CFSTI: HC $3.00/MF $0.65 CSCL 20M

Black-body radiation is investigated with emphasis placed on a solution of the Planck integral, which is suitable for computer and hand calculation. A computer program using this method has been included as well as graphs and tables of Planck functions and Planck integrals, which can be used for a wide range of wave numbers, ν, ($=\lambda^{-1}$), and temperatures, T, in degrees Kelvin. A suitable range is: ν from 0.001 to 300.000 cm^{-1} (λ from 10 meters to 333.3 angstroms) for temperatures between 1°K and 25,000°K.
Author

N68-18499*# Douglas Aircraft Co., Inc., Santa Monica Calif. Missile and Space Systems Div.
STUDY OF NONPARAMETRIC TECHNIQUES FOR ESTIMATING RELIABILITY AND OTHER LIFE QUALITY PARAMETERS Final Report
V. K. Murthy Feb. 1968 117 p refs
(Contract NASw-1367)
(NASA-CR-93483; DAC-62180) CFSTI: HC $3.00/MF $0.65 CSCL 12A

This study was undertaken to carry out a comprehensive investigation of procedures for estimating probability distributions of life lengths, as well as the corresponding probability densities and hazard functions, in situations where little or no information is available on the family of the underlying failure laws. Nonparametric techniques were developed for obtaining estimates and confidence bands for various kinds of samples of life lengths and large-sample techniques are derived and discussed. Discontinuities of the life distribution function correspond to times at which the devices considered are exposed to increased "instantaneous hostility." A statistical test is proposed which makes it possible to determine whether such moments of increased instantaneous hostility are present. Exact small-sample probability distributions as well as the corresponding asymptotic (large-sample) distributions to selected Rényi-type statistics are presented. Extensive numerical tabulations of these distributions are summarized in compact tables.
Author

N68-18510# Harvard Univ., Cambridge, Mass. Div. of Engineering and Applied Physics.
ERROR BOUNDS FOR QUASI-HARMONIC OSCILLATIONS: RESONANT CASE
R. J. McLaughlin Sep. 1967 52 p refs
(Contract Nonr-1866(16))
(TR-450; AD-664222)

The most common procedure for constructing the periodic solution of a quasilinear differential equation with periodic right-hand side usually involves an iterative procedure which theoretically yields the exact solution only after an infinite number of iterations, and provided that the perturbing parameter in the differential equation is sufficiently small. Such a procedure has the important practical defects that (1) the method usually gives no indication of how small the parameter must be for convergence to the true solution, and (2) the method usually gives little indication of how much error remains after the finite number of iterations with which one must be satisfied in any practical calculation. A previous report describes a functional equation method for estimating convergence intervals and truncation errors for the periodic series solutions of scalar, quasi-harmonic equations of the non-resonant type. The method is due originally to A. M. Lyapunov, and has been discussed primarily in connection with the convergence interval problem by Ryabov in the Soviet Union. The present report extends our previous discussion to the resonant case. The general form of the functional equations is derived for this case, and a practical construction procedure and solution method for the functional equations are given.
TAB

N68-18529# Iowa State Univ. of Science and Technology, Ames.
EIGENVECTORS OF A GENERAL COMPLEX MATRIX BY NORM REDUCTION
Albert Maurice Erisman (M.S. Thesis) Aug. 1967 57 p refs
(Contract W-7405-ENG-82)
(IS-T-207) CFSTI: HC $3.00/MF $0.65

Eigenvectors of a real matrix are found by applying the theorem: "$\bar{x}\bar{y}^{\bullet}-\bar{x}\bar{y}^{\bullet}$ A=0 if and only if $\bar{x}$ and $\bar{y}^{\bullet}$ are column and row eigenvectors respectively of the matrix A corresponding to the same eigenvalue." It is shown that it is sufficient to consider real matrices since any complex matrix A can be transformed to a real matrix whose eigenvalues are those of A along with the conjugates of those of A. Questions relating to convergence of the method used are considered. This method has application to finding all eigenvectors, some eigenvectors, or correcting approximate eigenvectors. Examples illustrating the first and third of these applications are given.
Author (NSA)

N68-18538# Purdue Univ., Lafayette, Ind. Dept. of Statistics.
SELECTION PROCEDURES FOR RESTRICTED FAMILIES OF PROBABILITY DISTRIBUTIONS
Richard E. Barlow and Shanti S. Gupta Dec. 1967 26 p refs *Its* Mimeograph Ser. 132
(Contracts Nonr-1100(26); Nonr-3656(18))
(AD-664474) CFSTI: HC $3.00/MF $0.65

Let pi sub 1, pi sub 2,...pi sub k be k populations. The random variable X sub i associated with pi sub i has a continuous distribution F sub i, i = 1,2,...k. We are primarily interested in selecting a subset such that the probability is at least P star that the selected subset includes the population with the largest (smallest) quantile of a given order alpha(0 < alpha < 1). We assume each F sub i has a unique alpha-quantile, Xi sub(alpha i). Let F sub (i) (x) = F sub (i) denote the cumulative distribution function of the population with the ith smallest alpha-quantile. The report considers families of distributions ordered in a certain sense with respect to a specified continuous distribution G and considers a selection procedure which is different from the non-parametric procedure of Rizvi and Sobel (1967). TAB

N68-18548# Purdue Univ., Lafayette, Ind. Dept. of Statistics.
EXPONENTIAL ERGODICITY OF THE M/G/1 QUEUE
Marcel F. Neuts and Jozef L. Teugels Oct. 1967 19 p refs *Its* Mimeograph Ser. No. 126
(Contract Nonr-1100(62); Grant AF-AFOSR-955-65)
(AD-664471)

If an M (verticle line) G (verticle line) 1 queue has a service time distribution which is exponentially bounded, then most all important quantities of the queue have distributions, which are exponentially bounded. This is proved for the busy period, the number of customers served during a busy period, the waitingtime, the queuelength in continuous and in discrete time. The method of proof is based on the exponential ergodicity theorems for semi-Markov processes. Author (TAB)

N68-18577# Joint Publications Research Service, Washington, D. C.
TECHNICAL CYBERNETICS [TEKHICHESKAYA KIBERNETIKA]
5 Mar. 1968 236 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR (Moscow), no. 6, Nov.–Dec. 1967 p 1–159
(JPRS-44576) CFSTI: HC $3.00/MF $0.65

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1. SYNTHESIS OF LINEAR FORECAST SYSTEMS WITH RESPECT TO COMPLEX STATISTICAL QUALITY CRITERIA D. B. Yudin p 1–16 refs (See N68-18578 09-19)

2. APPLICATION OF THEORETICAL GAME METHODS TO EVALUATION OF THE VIABILITY OF COMPLEX SYSTEMS B. S. Fleyshman and V. F. Krapivin p 17–34 refs (See N68-18579 09-23)

3. STATISTICAL THEORY OF AUTOMATIC LEARNING SYSTEMS V. S. Pugachev p 35–59 refs (See N68-18580 09-10)

4. A CLASS OF INFORMATION PROCESSING PROBLEMS AT THE OUTPUT OF A COMMUNICATION LINE V. P. Zelenen'kiy p 60–69 refs (See N68-18581 09-07)

5. OPTIMAL DISTRIBUTION OF RESOURCES WITH ADDITIVE PURPOSE FUNCTIONS V. V. Kiryukhin p 70–77 refs (See N68-18582 09-19)

6. STOCHASTIC PERT PLANNING V. A. Barishpolets p 78–94 refs (See N68-18583 09-19)

7. DYNAMIC PROGRAMMING AND OPTIMAL PLACEMENT OF WELLS O. S. Gorbacheva p 95–101 refs (See N68-18584 09-19)

8. A GENERALIZATION OF SLIDING DUPLICATION I. A. Ushakov p 102–108 ref (See N68-18585 09-19)

9. RELIABILITY OF A DUPLICATED SYSTEM WITH LIMITED REPAIR B. A. Miskevich p 109–118 refs (See N68-18586 09-10)

10. DETERMINATION OF THE PROBABILITY OF FALSE FAILURE IN AUTOMATIC MONITORING V. S. Zaritskiy and L. S. Sonin p 119–127 refs (See N68-18587 09-10)

11. GRAPHICO ANALYTIC METHOD OF EVALUATING THE QUALITY OF DIGITAL AUTOMATA DESIGNS Ye. A. Drozdov p 128–136 refs (See N68-18588 09-10)

12. RATIONAL ENCODING OF AUTOMATA WITH THE HELP OF CANONICAL GRAPHS S. P. Kartasheva p 137–155 refs (See N68-18589 09-08)

13. METHOD FOR OBTAINING BINARY SYMBOLS WITH A GIVEN PROBABILITY OF THEIR OCCURRENCE A. V. Kobchikov p 156–163 refs (See N68-18590 09-08)

14. A METHOD OF NUMERICAL ANALYSIS OF COMPLEX SYSTEMS M. M. Gerdov p 164–175 refs (See N68-18591 09-19)

15. ALGORITHM FOR THE SOLUTION OF A SYSTEM OF LOGICAL EQUATIONS FOR MAJORITAL DECOMPOSITION OF FUNCTIONS OF TWO VALUED LOGIC A. M. Tomashpol'skiy p 176–183 ref (See N68-18592 09-19)

16. EVALUATING THE EFFECTIVENESS OF PARAMETERS USED WHEN CLASSIFYING OBJECTS OR PHENOMENA Yu. V. Vagin p 184–194 refs (See N68-18593 09-34)

17. A METHOD OF SYNTHESIS OF SELF ADJUSTING STABILIZATION SYSTEMS FOR DYNAMIC CHARACTERISTICS A. I. Petrov and V. I. Kukhtenko p 195–207 refs (See N68-18594 09-10)

18. AN EXTREMAL SYSTEM OF THE STEP TYPE WITH AN INERTIAL OBJECT N. N. Leonov p 208–221 refs (See N68-18595 09-10)

19. CALCULATING THE REACTION OF DENSE COMPOUND FILTERS TO SMOOTH SIGNALS A. J. Protopopov p 222–235 (See N68-18596 09-07)

N68-18578# Joint Publications Research Service, Washington, D. C.
SYNTHESIS OF LINEAR FORECAST SYSTEMS WITH RESPECT TO COMPLEX STATISTICAL QUALITY CRITERIA
D. B. Yudin *In its* Tech. Cybernetics 5 Mar. 1968 p 1–16 refs (See N68-18577 09-19)

A formal basis is introduced for concepts which permit a strict statement of the forecasting problem, and investigation of the possibilities of synthesizing linear smoothing and extrapolation system with respect to complex statistical quality criteria. The statements of the problem and discussion of the results are presented both in terms of random variables and of weight functions. The arguments presented show that both the random variable and weight approaches to the problem of linear predictions are equivalent. E.J.S.

N68-18582# Joint Publications Research Service, Washington, D. C.
OPTIMAL DISTRIBUTION OF RESOURCES WITH ADDITIVE PURPOSE FUNCTIONS
V. V. Kiryukhin *In its* Tech. Cybernetics 5 Mar. 1968 p 70–77 refs (See N68-18577 09-19)

A method is proposed for the solution of a problem in integral convex programming in some cases more effective than the known algorithm. Author

N68-18583# Joint Publications Research Service, Washington, D. C.
STOCHASTIC PERT PLANNING
V. A. Barishpolets *In its* Tech. Cybernetics 5 Mar. 1968 p 78–94 refs (See N68-18577 09-19)

The algorithm for analyzing a PERT model with stochastic structure is described. Author

N68-18584# Joint Publications Research Service, Washington, D. C.
DYNAMIC PROGRAMMING AND OPTIMAL PLACEMENT OF WELLS
O. S. Gorbacheva *In its* Tech. Cybernetics 5 Mar. 1968 p 95–101 refs (See N68-18577 09-19)

A mathematical model is constructed for optimal placement of a system of wells in a section of groundwater horizon. As a result a multiextremal problem of mathematical programming is obtained. A procedure is indicated which permits conversion of this problem into a form which is convenient for the use of the dynamic programming system on which the algorithm proposed in this work is based. Author

N68-18585# Joint Publications Research Service, Washington, D. C.

A GENERALIZATION OF SLIDING DUPLICATION

I. A. Ushakov *In its* Tech. Cybernetics 5 Mar. 1968 p 102–108 ref (See N68-18577 09-19)

Systems are investigated with branched reserve for which the operating elements are separated into groups each of which has its own sliding reserve, and several groups of reserve elements have their own sliding reserve. For such systems the generating functions are found for the number of operating elements which have failed in the case where the reserve elements are in the loaded and unloaded state. Author

N68-18591# Joint Publications Research Service, Washington, D. C.

A METHOD OF NUMERICAL ANALYSIS OF COMPLEX SYSTEMS

M. M. Gerdov *In its* Tech. Cybernetics 5 Mar. 1968 p 164–175 refs (See N68-18577 09-19)

On the basis of the formulas of numerical representation of discrete systems, the concepts of derivative and primitive of a predicate function are introduced and a basis established for them. Their basic properties are investigated. Author

N68-18592# Joint Publications Research Service, Washington, D. C.

ALGORITHM FOR THE SOLUTION OF A SYSTEM OF LOGICAL EQUATIONS FOR MAJORITAL DECOMPOSITION OF FUNCTIONS OF TWO VALUED LOGIC

A. M. Tomashpol'skiy *In its* Tech. Cybernetics 5 Mar. 1968 p 176–183 ref (See N68-18577 09-19)

A simple algorithm is proposed for the solution of a system of logical equations to which testing the possibility of majoritaf decomposition of the functions of the algebra of logic leads. The number of operations in the algorithm is proportional to the number of equations in the system. Author

N68-18609# Miami Univ., Coral Gables, Fla.

CONVERGENCE OF COMPLEX LAGRANGE INTERPOLATION POLYNOMIALS WITH NODES LYING ON A PIECEWISE ANALYTIC JORDAN CURVE WITH CUSPS

P. J. O'Hara, Jr. Dec. 1967 52 p refs

(Grants AF-AFOSR-358-64; AF-AFOSR-358-66)

(AFOSR-67-2550; AD-664083) CFSTI: HC $3.00/MF $0.65

Let the analytic and univalent function z = phi(w) map the exterior of absolute value of w = 1 onto the exterior region of a Jordan curve C, so that infinity (opposite pointed arrows) infinity, and let phi be extended so as to give a topological map of absolute value of w = 1 onto C. Let S sub n = (phi(exp 2 pi ik/(n + 1)); k = 0, 1, ..., n) and let f(z) be continuous on C. Let L sub n(f; z) be the polynomial of degree at most n which interpolates to f in the points S sub n. The problem with which this paper is basically concerned is that of proving that with certain restrictions on C which include rectifiability, the equation Lim as n approaches infinity (L sub n(f; z)) = 1/2 pi i the integral over C of the quantity (f(z prime)dz prime/(z prime - z)) holds for z epsilon Int C, and the limit is uniform on any compact subset of Int C. TAB

N68-18631# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

HERALD OF LENINGRAD UNIVERSITY, MATHEMATICS, MECHANICS AND ASTRONOMY SERIES, NO. 1

27 Apr. 1967 250 p refs Transl. into ENGLISH of Vestn. Leningr. Univ., Ser. Mat., Mekh. i Astron., no. 1, 1963 p 1–158 (FTD-MT-64-145; AD-663914)

A compilation of articles is presented on mathematical analysis techniques, fluid and gas dynamics, and astronomy. For individual titles, see N68-18632 through N68-18652.

N68-18632# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ABOUT POSSIBLE EXTENSION OF THE IDEA OF SOLUTION FOR LINEAR AND QUASI-LINEAR ELLIPTIC EQUATIONS OF THE SECOND ORDER [O DOPUSTIMYKH RASSHIRENIYAKH PONYATIYA RESHENIYA DLYA LINEYNYKH I KVAZILINEYNYKH ELLIPTICHESKIKH URAVNENIY VTOROGO PORYADKA]

O. A. Ladyzhenskaya and N. N. Ural'tseva *In its* Herald of Leningrad Univ., Math., Mech. and Astronomy Ser., No. 1, 1963 27 Apr. 1967 p 7–25 refs (See N68-18631 09-19)

Examples are presented which make known necessary conditions for the linear equations with nondifferentiable unbounded coefficients and the quasi-linear equations to admit weak solutions of the classes generated by the main terms of the equations. Author

N68-18633# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

GENERATORS IN ERGODIC THEORY [OBRAZUYUSHCHIYE V ERGODICHESKOY TEORII]

V. A. Rokhlin *In its* Herald of Leningrad Univ., Math., Mech. and Astronomy Ser., No. 1, 1963 27 Apr. 1967 p 27–34 refs (See N68-18631 09-19)

The following theorems are proved: (1) Every aperiodic automorphism with finite entropy of a Lebseque space has a generator with finite entropy. (2) The entropy h(T) of any aperiodic automorphism T satisfies h(T) = inf H(Ξ), where Ξ is a generator and H(Ξ) is its entropy. Author

N68-18634# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

STABILITY OF SOLUTION OF MINKOWSKI PROBLEM [USTOYCHIZOST' RESHENIYA PROBLEMY MINKOVSKOGO]

Yu. A. Volkov *In its* Herald of Leningrad Univ., Math., Mech. and Astronomy Ser., No. 1, 1963 27 Apr. 1967 p 35–47 refs (See N68-18631 09-19)

Consideration is given to the Minkowski problem, which consists of the determination of a closed convex surface from a given surface function. In the case of regular surfaces, a surface function is defined by giving the Gaussian curvature as a function of the surface normal, while in the case of a polyhedron, it is specified by giving the outer normals and the areas of the faces. Author

N68-18635# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ABOUT REPRESENTATION OF A FUNCTION OF TWO VARIABLES BY THE DIFFERENCE OF CONVEX FUNCTIONS [O PREDSTAVLENII FUNKTSII DVUKH PEREMENNYKH RAZNOST'YU VYPUKLYKH FUNKTSIY]

V. A. Zalgaller *In its* Herald of Leningrad Univ., Math., Mech. and Astronomy Ser., No. 1, 1963 27 Apr. 1967 p 49–51 refs (See N68-18631 09-19)

A process which leads to minimal expansion of the function of two variables as difference of two convex functions is given. The process disconverges in the case when such expansion is impossible. The connection of this problem with linear programming is demonstrated for piece-linear functions. Author

N68-18636# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE QUESTION ABOUT STABILITY OF SOLUTIONS OF EQUATIONS OF THE ELLIPTIC TYPE [K VOPROSU OB USTOYCHIVOSTI RESHENIY URAVNENIY ELLIPTICHESKOGO TIPA]
Ye. P. Sen'kin *In its* Herald of Leningrad Univ., Math., Mech. and Astronomy Ser., No. 1, 1963 27 Apr. 1967 p 53–55 refs (See N68-18631 09-19)

It is proved that estimations for the solution of the Monge–Ampere equation can be deduced from the estimations obtained for linear equations. Author

N68-18637# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ON THE EXISTENCE OF CLOSED CONVEX POLYHEDRONS WITH GIVEN CURVATURES OF VERTICES IN N-DIMENSIONAL EUCLIDEAN AND LOBACHEVSKIAN SPACES [O SUSHCHESTVOVANII ZAMKNUTYKH VYPUKLYKH MNOGOGRANNIKOV S ZADANNYMI KRIVIZNAMII VERSHIN V N-MERNYKH PROSTRANSTVAKH YEVKLIDA I LOBACHEVSKOGO]
A. A. Zil'berberg *In its* Herald of Leningrad Univ., Math., Mech. and Astronomy Ser., No. 1, 1963 27 Apr. 1967 p 57–63 refs (See N68-18631 09-19)

It is proved that in the n-dimensional Euclidean or Lobachevskian spaces there is a closed convex polyhedron with any given curvatures of the vertices $\omega_1, \ldots, \omega_m$ which satisfy obviously necessary conditions. Author

N68-18638# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ABOUT DETERMINATION OF A SURFACE BY SUPPORTING FUNCTION [O ZADANII POVERKHNOSTI OPORNOY FUNKTSIYEY]
Yu. G. Dutkevich *In its* Herald of Leningrad Univ., Math., Mech. and Astronomy Ser., No. 1, 1963 27 Apr. 1967 p 65–72 refs (See N68-18631 09-19)

It is stated that a smooth surface with the locally one-to-one spherical image is uniquely determined by the set of its tangent planes. Author

N68-18639# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ON DOUBLE SUMS, CONNECTED WITH THE ZEROS OF THE DIRICHLET L-SERIES [O DVOYNYKH SUMMAKH SVYAZANNYKH S NULYAMI L-RYADOV DIRIKHLE]
A. I. Vinogradov *In its* Herald of Leningrad Univ., Math., Mech. and Astronomy Ser., No. 1, 1963 27 Apr. 1967 p 73–78 refs (See N68-18631 09-19)

Sums of the characters with coefficients are considered. Values depending on the imaginary parts of the zeros of the Dirichlet L-series are taken as coefficients. Author

N68-18640# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ABOUT THE MAXIMUM PRINCIPLE FOR ONE CLASS OF OPERATORS IN BANACH SPACE [O PRINTSIPE MAKSIMUMA DLYA ODNOGO KLASSA OPERATOROV V PROSTRANSTVE BANAKHA]
V. G. Maz'ya *In its* Herald of Leningrad Univ., Math., Mech. and Astronomy Ser., No. 1, 1963 27 Apr. 1967 p 79–85 refs (See N68-18631 09-19)

A linear functional is denoted in a real Banach space, and its properties are formulated. Maximum principles for the equations are stated, and the class to which the fourth order elliptic operator (corresponding to the Dirichlet problem) belongs is shown. Author

N68-18641# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
FORMULAS OF SUMMATION [O FORMULAKH SUMMIROVANIYA]
V. V. Pototskiy *In its* Herald of Leningrad Univ., Math., Mech. and Astronomy Ser., No. 1, 1963 27 Apr. 1967 p 87–96 refs (See N68-18631 09-19)

An application of general formula of summation to two particular cases is described: (1) to the summation of the function over integer points of n-dimensional ellipsoid; and (2) to the numerical function. Author

N68-18651# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
NECESSARY AND SUFFICIENT CRITERION COMPACTNESS OF INSERTION [NEOBKHODIMYY I DOSTATOCHNYY PRIZNAK KOMPAKTNOSTI VLOZHENIYA]
A. G. Ramm *In its* Herald of Leningrad Univ., Math., Mech. and Astronomy Ser., No. 1, 1963 27 Apr. 1967 p 189–191 refs (See N68-18631 09-19)

The necessary and sufficient indication of the compactness of the imbedding operator is obtained with certain assumptions about the Banach spaces. Author

N68-18680# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
PRINCIPLES OF CONSTRUCTION OF FLAT OUTLINES [PRINTSIPY POSTROYENIYA PLOSKIKH OBVODOV]
I. I. Kotov *In its* News of Inst. of Higher Learning. Aeron. Eng. 10 Apr. 1967 p 109–114 refs (See N68-18668 09-23)

The methods used for mathematically fitting a smooth profile through a number of points under several conditions are briefly discussed. Profile generation using a succession of arcs, arcs of second degree curves, integral–graphical methods, and arcs of ellipses is discussed briefly with a short paragraph for each. A general discussion of all of the methods concludes that for a given number of constraints (consisting of points, slopes, tangents, etc.) one has to use a method with at least as many parameters to be specified in the mathematical expression of the arcs. Examples of four, five, six, seven, and eight parameter curves which can be used are given respectively. Author

N68-18681# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
DETERMINATION OF THE DISTRIBUTION PARAMETERS OF LINEAR DIMENSIONS WHEN TREATING A BATCH OF COMPONENTS [OPREDELENIYE PARAMETROV RASPREDELENIYA LINEYNYKH RAZMEROV PRI OBRABOTKE PARTII DETALEY]
A. S. Shevelev *In its* News of Inst. of Higher Learning. Aeron. Eng. 10 Apr. 1967 p 115–122 refs (See N68-18668 09-23)

Under assumptions of a normal process, independent random variables with fixed variance and linearly changing mean, the author computes the cost of one run of a production process. Author

N68-18767# Johns Hopkins Univ., Baltimore, Md. Dept. of Statistics.
ON ASYMPTOTICALLY ROBUST COMPETITORS OF THE ONE-SAMPLE T-TEST
Daniel A. Bloch and Joseph L. Gastwirth Mar. 1967 13 p refs (Contract Nonr-4010(09); Grant NSF GP-6225) (TR-70; AD-654460)

Although the T-Test is one of the most commonly used statistical procedures, its behavior is somewhat sensitive to the assumption that observations come from a normal distribution. Recently, it has been shown that 'quick estimators', i.e., estimators which are linear combinations of a few sample quantiles are robust estimators of the location parameter for a large class of symmetric unimodal densities.

In order to use the median or any other 'quick estimator' as a test we must estimate its variance, or in large sample its asymptotic variance. The present paper is concerned with estimating (1/F squared) (nu subscript p) where nu subscript p is the true value of the p-th population quantile and F(x) is the density function. The estimator we consider has properties similar to those of Rosenbalatt's estimate of a density function. TAB

N68-18817*# Scripta Technica, Inc., Washington, D. C.
RIEMANN'S PROBLEM WITH CONTINUOUS COEFFICIENT [KRAYEVAYA ZADACHA RIMANA S NEPRERYVNYM KOEFFITSIYENTOM]
I. B. Simonenko Washington NASA Mar. 1968 6 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR, v. 124, no. 2, 1959 p 278–281
(Contract NASw-1694)
(NASA-TT-F-11551) CFSTI: HC $3.00/MF $0.65 CSCL 12A

A procedure is presented for solving Riemann's boundary-value problem for the boundary between a multiply-connected region and its complement. A result found previously by Gakhov by relaxing the conditions on the given functions is generalized. A slight change in one of the given functions does not appreciably change the result, so that a sequence of approximations is possible. Author

N68-18819# RAND Corp., Santa Monica, Calif.
COMPUTING (g,w)-OPTIMAL POLICIES IN DISCRETE AND CONTINUOUS MARKOV PROGRAMS
Eric V. Denardo Jan. 1968 33 p refs
(Contract F44620-67-C-0045)
(RM-5538-PR; AD-664323)

The study shows how to compute policies that maximize a certain reasonable criterion (i.e., policies that are (g,w)-optimal) for the undiscounted infinite-horizon versions of two Markov decision problems--one a discrete-time model and the other a continuous-time model. The approach used is to parse the overall problem into at most three smaller problems that can be solved in sequence by the methods of linear programming or policy iteration. Author (TAB)

N68-18823*# Analytical Mechanics Associates, Westbury, N. Y.
ONE-DIMENSIONAL SEARCH COMBINING: GOLDEN SECTION AND CUBIC FIT TECHNIQUES Quarterly Report
Geraldine Guilfoyle, Ivan Johnson (NASA. Manned Spacecraft Center), and Patrick Wheatley (NASA. Manned Spacecraft Center) Jan. 1967 20 p ref
(Contract NAS9-4036)
(NASA-CR-65994; Rept.-67-1; QR-8) CFSTI: HC $3.00/MF $0.65 CSCL 12A

A one-dimensional search routine combining two different techniques is presented. The techniques are: (1) The golden section is an iteration scheme to nest a sequence of intervals around the function's minimum. Each iteration reduces the size of the interval until it is small enough to justify taking its midpoint as the approximation to the abscissa of the function's minimum. (2) Cubic fit method is a scheme to approximate the function with a cubic equation. The program which can be logically divided into three parts is outlined, and a detailed flow chart of each is presented. B.S.D.

N68-18833# Stanford Univ., Calif. Dept. of Statistics.
LOW PASS FILTER DESIGN
Hirotugu Akaike 30 Nov. 1967 45 p refs
(Grant DA-ARO(D)-31-124-G726)
(AROD-2025.20-M; TR-20; AD-664130) CFSTI: HC $3.00/MF $0.65

The design and evaluation of low pass filters in statistical analyses of time series is approached by using two indices, one concerned with the fidelity of the bandwidth and the other with the concentration of band pass around frequency zero. These two indices and the output power of the filter when it is excited by a white noise with unit spectral density obtain a two dimensional space representation for the filters. Numerical computations for impulse response functions of trigonometric polynomials show that low pass filters with negative values at both ends of the impulse response functions can be good low pass filters. The application of spectrum windows in the estimation of spectra is the low pass filtering Fourier transform of sample covariance function in the frequency domain. A possibility of extending the present design procedure for the design of data windows is suggested. G.G.

N68-18876# Los Alamos Scientific Lab., N. Mex.
ON RECURSIVELY DEFINED GEOMETRICAL OBJECTS AND PATTERNS OF GROWTH
R. G. Schrandt and S. M. Ulam 27 Nov. 1967 19 p ref
(Contract W-7405-ENG-36)
(LA-3762) CFSTI: HC $3.00/MF $0.65

Illustrations are given of computer-generated patterns exhibited by figures growing according to certain recursive rules. Examples of growing patterns in two- and three-dimensional space are given. Patterns are discussed in an infinite strip of a given width where periodic growth is observed. When modification of the rules of growth allows portions of the pattern to die out, configurations split into separate connected pieces, exhibiting the phenomena of both motion and some self-reproduction. A simple conflict rule together with this modification allows a game of survival between two systems growing in a finite portion of the plane. The examples show both the complexity and richness of forms obtained from starting with a simple geometrical element and the application of a simple recursive rule. Author (NSA)

N68-19041* Boeing Co., Seattle, Wash. Space Div.
AN INTRODUCTION TO MULTIVARIABLE SEARCH TECHNIQUES FOR PARAMETER OPTIMIZATION (AND PROGRAM AESOP)
D. S. Hague and C. R. Glatt [1968] 91 p refs
(Contract NAS2-4507)
(NASA-CR-73200) CSCL 12A

Introductory data are presented for the field of multivariate optimization of nonlinear, parametrically defined systems, and numerical techniques are described for solving problems in this area. A detailed description is provided of the basic search algorithms used in the Automated Engineering and Scientific Optimization Program (AESOP), and it is shown how preprogrammed models of parametrically defined systems can be coupled to them. These preprogrammed algorithms consist of: sectioning parallel to the axes, adaptative creeping, magnification, steepest descent method, pattern, quadratic, random point, random ray, and Davidon's method searches. Engineering problems solved by coupling AESOP and parametric models are tabulated. Methods of locating multiple extremals are discussed, and additional search procedures which can readily be added to AESOP are provided. E.J.S.

N68-19109*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE THEORY AND APPLICATION OF LEAST SQUARES
Gene A. Smith Dec. 1967 45 p refs
(NASA-TM-X-63127; X-565-67-601) CFSTI: HC $3.00/MF $0.65 CSCL 12A

The theory of the least squares method and its application as an analytical approach to curve fitting, data smoothing, and solving many overdetermined sets of equations are presented. Included are a few examples of easily programmed equations which serve a variety of purposes as well as the more complex general nonlinear equation approach. R.N.A.

N68-19115 Yale Univ., New Haven, Conn.
HIGHER OBSTRUCTIONS TO SMOOTHING
Douglas Ross Anderson (Ph.D. Thesis) 1967 80 p
Available from Univ. Microfilms: HC $4.20/MF $3.00 Order No. 67-6989

The existence of obstruction theories for smoothing a piece-wise linear manifold have been well known for some time. Spivak's dissertation, together with a celebrated theorem due to W. Browder, E. Brown, and S. P. Novikov essentially provide the outlines of an obstruction theory for the problem of whether a given space X has the homotopy type of a smooth manifold. It is the object of this dissertation to investigate the structure of the higher obstructions in both the use theories and to explore the relationships between them. In particular we show that the higher obstructions are cosets of $H^q(X;G)$ modulo some subgroup where G is an appropriate coefficient group, and that the subgroup depends only on the homotopy type of X. We also prove the Theorem: If M is an (n-1) connected PL manifold with a odd, then the primary obstruction to smoothing M is a homotopy type invariant. Finally we give examples to show the higher obstructions to smoothing M are not homotopy type invariants. Dissert. Abstr.

N68-19116 IIT Research Inst., Chicago, Ill.
ON NUMERICAL STABILITY OF A PROCEDURE FOR INITIAL VALUE PROBLEMS
Thomas Church (Ph.D. Thesis) 1967 116 p
Available from Univ. Microfilms: HC $5.80/MF $3.00 Order No. 67-7176

The results presented deal with partial differential equations. The starting point in the present investigation is to assume that the given value problem has a solution which may be written as a Taylor series. The first term on the right is the initial data function. The next term is obtained from the equation(s) which define(s) the initial value problem. Subsequent terms are obtained by differentiating the governing differential equation with respect to time and eliminating all time derivatives in favor of space derivatives. The resulting solution series may or may not converge; convergence depends on the given governing equation and also on the given initial data function. The properties of these solution series are investigated. Dissert. Abstr.

N68-19125 Texas Univ., Austin.
HOMOMORPHIC IMAGES OF COMPACTLY GENERATED LATTICES
Thomas Gerald Newman (Ph.D. Thesis) 1967 43 p
Available from Univ. Microfilms: HC $3.00/MF $3.00 Order No. 67-8141

In this paper various properties of homomorphisms and homomorphic images of compactly generated lattices are studied. The importance of the lattice of ideals in the theory of compactly generated lattices is established in the following theorem. Let M be a lattice and let f be a homomorphism of M into a compactly generated lattice L. There ixists a unique join-complete homomorphism f^* from I(M) into L such that $f^*(\phi) = 0$ and $f^*((a]) = f(a)$ for all $a \in M$. This thorem together with other results makes possible a characterizqtion of those lattices which are retracts of compactly generated lattices. As an application, a characterization of congruence relations on a distributive lattice is developed in terms of continuous mappings between certain topological spaces. Dissert. Abstr.

N68-19130 Texas Univ., Austin.
CONTRIBUTIONS TO THE THEORY OF HIGHER DEGREE EXTENSORS AND RELATED TOPICS
Philip Stockton Morey, Jr. (Ph.D. Thesis) 1967 70 p
Available from Univ. Microfilms: HC $3.80/MF $3.00 Order No. 67-8137

The purpose of this study is to extend the concept of higher degree ordinary extensors and to investigate some of the properties and applications of these quantities. The concept of second degree ordinary extensors comes from generalizations of the transformation laws. The Kth degree ordinary extensor concept is formulated from considerations of the transformation laws. We show that the calculus of first degree extensors may be extended to higher degree extensors by suitable definitions. One special property of higher degree extensors investigated is horizontal contraction, a summation within an extensor multiple index set, which yields an extensor of lower degree. By use of the transformation law, together with the contraction and quotient laws, we show that certain summations are the components of first degree extensors. This process of horizontal contraction does not have an analogue in tensor analysis or in the theory of first degree extensors. Dissert. Abstr.

N68-19144*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
A NEW METHOD OF TESTING SMALL SAMPLES FOR GOODNESS OF FIT TO NORMAL POPULATIONS
Peter D. Argentiero and Robert H. Tolson Washington Mar. 1968 319 p refs
(NASA-TN-D-4405) CFSTI: HC $3.00/MF $0.65 CSCL 12A

The frequency function is derived for a normal population with unknown mean and variance and from which has been chosen a sample of specified size with zero mean and a standard deviation of one. Tables of areas and ordinates of this frequency function for sample sizes between 20 and 170 are provided. The existence of such tables provides a method of testing small samples for goodness of fit to normal populations without the necessity of replacing unknown population parameters with maximum likelihood estimates. Therefore, this method is an improvement of the usual method of testing the hypothesis that a sample has been chosen from a normal population with unspecified mean and variance. An example is given to illustrate the use of the tables. Author

N68-19183 Oklahoma Univ., Norman.
EXISTENCE AND OSCILLATION THEOREMS FOR A CLASS OF NON-LINEAR SECOND ORDER DIFFERENTIAL EQUATIONS
John Wesley Hooker (Ph.D. Thesis) 1967 52 p
Available from Univ. Microfilms: HC $3.00/MF $3.00 Order No. 67-7330

This paper is concerned with the existence and oscillation of solutions of some initial value and boundary value problems associated with the real, scalar differential equation $y'' + yF(t,y,y') = 0$ on a compact interval [a,b]. The function $F = F(t,y,r)$ is assumed to be real-valued, continuous, and bounded below and above by non-negative, continuous functions $\hat{F} = \hat{F}(y)$ and $\check{F} = \check{F}(y)$ which satisfy certain monotoneity properties; F is also assumed to satisfy a local Lipschitz condition with respect to y and r. It is shown that there exist positive values $\mu_1 < \mu_2 < \ldots$ such that for each n = 1,2, ... the above equation has a solution which satisfies $y(a) = y(b) = 0$, $y'(a) = \mu_n$, and which vanishes exactly n-1 times in the open interval (a,b). A similar result is established for the boundary value problem involving the above differential equation and the boundary conditions $y(a) = y'(b) = 0$. The proofs of the above results are based on some preliminary estimates, in terms of the initial slope, for the distance between successive zeros of solutions of the given equation which satisfy the condition $y(a) = 0$. Dissert. Abstr.

N68-19233 Texas Univ., Austin.
REPRESENTATION OF UNIFORMIZING FUNCTIONS FOR CERTAIN SIMPLY AND DOUBLY CONNECTED RIEMANN SURFACES
Joe Eckley Kirk, Jr. (Ph.D. Thesis) 1967 72 p
Available from Univ. Microfilms: HC $4.00/MF $3.00 Order No. 67-8119

Two classes of Riemann surfaces are considered. The first is a class of simply connected surfaces. A member of this class is formed by joining the z-sphere S_n, n=1,2,.... to S_{n+1} along

an interval (finite in length) of the positive real axis so that first order branch points are at the ends of the interval. A member of this class of surfaces is shown to be parabolic and a uniformizing function is represented as an infinite product formed from its zeroes and poles. The derivative is also represented as an infinite product. The second class considered contains doubly connected members. The z-sphere S_{-n}, $n = 1,2,\ldots$, is joined as before to S_{-n-1} along an interval (finite in length) of the positive real axis. Members of this class are shown to be conformally equivalent to the once punctured plane and a uniformizing function g is represented as an infinite product formed from its zeroes u_p and poles v_p, where p denotes a non-zero integer. Dissert. Abstr.

N68-19283 IIT Research Inst., Chicago, Ill.
THE ALGEBRA OF MULTIPLACE FUNCTIONS UNDER COMPOSITION
Herbert Ian Whitlock (Ph.D. Thesis) 1967 54 p
Available from Univ. Microfilms: HC $3.00/MF $3.00 Order No. 67-7027

A p-place Menger algebra of functions over a set S is a collection of p-place functions *M* mapping the Cartesian product of S^p into S such that for all $F,G_1,\ldots G_p$ the composite $F(G_1,\ldots G_p)$ is in *M*. The composite is a p-place function whose value at $(x_1,\ldots x_p)$ in S^p is given by $F(G_1(x_1,\ldots x_p),\ldots G_p(x_1,\ldots x_p))$. In a similar manner the composite of a p-place function with p q-place functions can be defined. In contrast to the theorem in semigroup theory about the simplicity of the subsemigroups of a singly generated semi-group, I have proved the following statement. Every finitely generated p-place Menger algebra is isomorphic to a sub-algebra of a singly generated algebra. Dissert. Abstr.

N68-19293 Arizona Univ., Tucson.
THE STRUCTURE OF CERTAIN TWO-DIMENSIONAL PROBABILITY MEASURES
David S. Crosby (Ph.D. Thesis) 1967 86 p
Available from Univ. Microfilms: HC $4.60/MF $3.00 Order No. 67-6938

It is found that a large class of two-dimensional probability measures are absolutely continuous with respect to the measure defined by the product of the marginal measures. These include the most common two-dimensional probability measures of mathematical statistics. By considering the measure as an integral with respect to the product measure, new proofs are given for known results. Necessary and sufficient conditions are given on the conditional expectation for a two-dimensional measure to belong to an especially simple class of two-dimensional measures with given marginals. In certain special cases the marginals of members of this class are shown to be independent if and only if the distribution function of the sum of two marginals is equal to the convolution of the distribution functions of the marginals. If two random variables have non-zero covariance and if their two-dimensional Lebesgue–Stieltjes measure is of this class then the measure is shown to be completely determined by the two regression curves. Dissert. Abstr.

N68-19321# Pennsylvania Univ., Philadelphia.
ANALYSIS OF CHEMICAL NOTATIONS PROJECT. 2: A MATHEMATICAL MODEL FOR CHEMICAL CIPHER SYSTEMS
George Weaver Feb. 1968 34 p refs

To delineate some of the significant properties of linear notation or cipher systems, consideration is given to the value of formal and mathematical methods for empirical sciences. Existing features are examined to determine their common features, and a sufficiently general nonmathematical characterization is given to encompass all of them. Concepts based on the theory of graphs and the theory of recursive functions are discussed, and informal proof of these theorems is presented. Cipher systems are characterized to give precise mathematical meaning to the concepts of completeness, uniqueness, and ambiguity. These results are applied to explore the relationship between weakly unique and unique systems, and also between mildly unique and strongly unique ones. It is shown that the task of formalizing any system involves showing that the rules of the system are recursive, and establishing the admissible sequences of these rules as well as establishing that the domain of each of these sequences is recursive relative to the set of all graphs. M.G.J.

N68-19377 Stanford Univ., Calif.
BALANCING STOCHASTIC LINES
David Rodger Freeman (Ph.D. Thesis) 1967 215 p
Available from Univ. Microfilms: HC $9.70/MF $3.00 Order No. 67-7915

A general model is presented for solving the line balancing problem with elemental times treated as random variables. The model assumes a set of N elements are given with an associated precedence matrix defining permissible orderings of the elements. The elemental times are assumed to be random variables with known density functions $f_i(\cdot)$ for $i = 1,2,\ldots N$. A desired output rate, Q, is given (items/min). The model outlines a four step procedure for finding a sequence of the N elements that can be partitioned into K stations at the lowest cost measured in terms of total cost/unit. This objective function possesses four terms: labor cost, inventory cost, facilities cost and penalty cost. Included in the dissertation are flow charts and ALGOL program listings for the general line simulator and the balance procedure. Dissert. Abstr.

N68-19430*# Florida State Univ., Tallahassee. Dept. of Statistics.
A MARTIAN QUARANTINE RISK MODEL
S. Eric Steg and Richard G. Cornell 8 Mar. 1968 30 p refs
(Grant NGR-10-004-029)
(NASA-CR-93695; TR-15) CFSTI: HC $3.00/MF $0.65 CSCL 12A

Efforts were undertaken to determine a meaningfully structured model using loss functions to assess the risk of employing a given decontamination procedure on all Martian unmanned landing craft. The relative risks of several spacecraft decontamination levels for a variety of loss functions using this model are evaluated. A basic approach is developed for assessing the validity of the choice of parameter relating to the probability of one viable organism aboard the landing capsule at the time of landing. This is then equated to the mean number of viable microorganisms on the capsule. The findings are related to the minimal form of decontamination required to achieve the suggested levels of cleanliness. M.G.J.

N68-19438*# Brown Univ., Providence, R. I.
GEOMETRIC THEORY OF FUNCTIONAL DIFFERENTIAL EQUATIONS
Jack K. Hale [1965] 31 p refs Presented at the Intern. Symp. on Differential Equations and Dynamical Systems, Puerto Rico, Dec. 1965
(Grants NGR-40-002-015; AF-AFOSR-693-65)
(NASA-CR-70260) CFSTI: HC $3.00/MF $0.65 CSCL 12A

Some aspects of certain functional differential retarded equations are discussed. The function space is taken to be the space $C = C(-r,0)$ R^n) of continuous functions mapping the interval $(-r, 0)$ into an n-dimensional real or complex vector space R^n. For any ϕ in C, $\|\phi\|$ is defined by relation $\|\phi\| = \max_{-r\le\theta\le 0} |\phi(\theta)|$ where $|x|$ is the norm of a vector x in R^n. General properties of solutions, and some geometric properties of linear autonomous equations and the variation of constant formula are discussed. Applications of the theory showing 1) the behavior near an equilibrium point of an autonomous equation, and 2) the behavior of equations with small parameter, are presented. Asymptotic theory for linear systems and the Floquet theory are also discussed. L.S.

N68-19447# Technische Hochschule Munchen (West Germany).
AN INSTALLATION FOR THE AUTOMATIC INPUT OF BODE DIAGRAMS [EINE ANLAGE ZUR AUTOMATISCHEN AUFNAHME DES BODE-DIAGRAMMS]
Klaus Wanser (Ph.D. Thesis) [1967] 19 p refs In GERMAN

A review of the theory of the Bode diagram is given which covers the frequency dependent characteristics, the differential equations for obtaining the frequency curve of a system, and the representation of the frequency effects in the Bode diagram. Circuitry and operation of the measuring arrangement are described, and measurements of amplitude and phase shift are discussed. The test frequency of this arrangement is between 10^{-3} and 10^{3} Hz and can be switched to three ranges of four decades each.
Transl. by K.W.

N68-19449*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
APPROXIMATE SOLUTION OF A TWO-POINT BOUNDARY VALUE PROBLEM
E. R. Lancaster Mar. 1968 6 p
(NASA-TM-X-63139; X-643-68-79) CFSTI: HC $3.00/MF $0.65 CSCL 12A

Formulas are derived for the approximate solution, and it is pointed out that the method is useful in calculating transfer trajectories for space vehicles, and in preliminary orbit determination from observations of the position of a spacecraft at two times.
Author

N68-19458# Montana State Univ., Missoula. Computer Center.
A GENERAL ITERATIVE METHOD FOR NONLINEAR EQUATIONS
Charles Bryan Jun. 1967 16 p refs
(TR-9; PB-176476) CFSTI: HC $3.00/MF $0.65

The paper discusses a general method of iteration for solving nonlinear equations of type (1) P (x) = 0, where P is a mapping from one Banach space into another. A special case of the general method will yield results on the method on nonlinear simultaneous displacements introduced by H. M. Lieberstein and studied by others. In section 2 the general method is formulated and conditions which are sufficient to guarantee both the feasibility and convergence of the method are given. The results are restated in section 3 for a strengthened results on the convergence of nonlinear simultaneous displacements.
Author

N68-19459# Montana State Univ., Missoula. Computer Center.
STABILITY BEHAVIOR OF DIFFERENTIAL EQUATIONS
John T. Clinker Jul. 1967 59 p refs
(TR-11; PB-176356) CFSTI: HC $3.00/MF $0.65

The paper investigates the stability behavior of solutions of systems of differential equations. Conditions for stability, asymptotic stability, uniform stability and uniform asymptotic stability of linear systems are given in terms of fundamental matrices. The variation of constants formula is used to examine the stability behavior of certain nonlinear systems. Also the second method of Lyapunov and the concept of total stability are discussed. Several examples illustrating the theorems and applications are included.
Author

N68-19462# Kansas State Univ., Manhattan.
REDUCTION IN DIMENSIONALITY, DYNAMIC PROGRAMMING AND QUASILINEARIZATION. 1: GENERAL THEORY
E. Stanley Lee 20 Jul. 1967 35 p refs Submitted for publication Sponsored in part by Dept. of the Interior Prepared jointly with the Kansas Water Resources Res. Inst., Contrib. No. 12
(SR-79; PB-176582) CFSTI: HC $3.00/MF $0.65

The quasilinearization technique is used to overcome the dimensionality difficulties of dynamic programming. The approach is based on the fact that if the difference or differential equations are linear, their closed form of solution can be obtained. This solution permits us to separate the effects due to the initial state from the effects due to the control variables. Using this separation combined with quasilinearization, the dimensionality of the functional equation of dynamic programming can be reduced to one in most cases. First, the optimization problem in cross-current extraction with a discontinuous objection function is used to illustrate the technique. Then the technique is generalized to systems of difference and differential equations with fairly general objective functions.
Author

N68-19463# Kansas Univ., Lawrence. Dept. of Mathematics.
FREDHOLM THEORIES IN VON NEUMANN ALGEBRAS 2
Manfred Breuer Oct. 1967 24 p refs
(Grant NSF GP-3460)
(TR-14; PB-176517) CFSTI: HC $3.00/MF $0.65

In the first part of this paper (PB-175 684) the foundations of a generalized theory of compact operators and Fredholm operators relative to a von Neumann algebra A were laid. The index group I (A) of A and the index map Index: F (A) approaches I (A) of the space F (A) of Fredholm elements of A were defined. Also the generalized Fredholm alternatives stating that 1 - C is Fredholm relative to A of index zero if C is compact relative to A were proved. In the second part of this paper the generalized Fredholm theory will be further developed. Some of the classical theorems of Atkinson, Gohberg–Krein and Cordes–Labrousse will be generalized. These generalizations will characterize the relative Fredholm elements modulo the relative compact elements, state the additivity of the index, and relate the index group I (A) to the group Pi sub O F (A) of connected components of F (A). In particular, it will be shown that if A is properly infinite, then the algebraic invariant I (A) of A is canonically isomorphic to the topological invariant Pi sub O F (A) of F (A). The von Neumann algebra analogue of a theorem on the multiplicativity of the index is also included.
Author

N68-19477# Forsvarets Forskningsanstalt, Stockholm (Sweden).
NUMBER OF WAYS FOR CHOOSING AN ALTERNATIVE. A COMBINATORIAL PROBLEM RELATED TO EULERIAN NUMBERS
Gustaf Borenius, Sture Danielson, and Birger Jansson Dec. 1967 9 p refs
(FOA-5, V. 1)

The number of procedures by which one alternative out of *n* may be chosen is discussed. The sequence of numbers obtained for $n = 1,2,3,\ldots$ is related both to Eulerian numbers and to Stirling's numbers of the second kind. The generating function, an asymptotic formula, and some arithmetic properties are demonstrated.
Author

N68-19482# System Development Corp., Santa Monica, Calif.
LIMITING DISTRIBUTIONS OF SOME VARIATIONS OF THE CHI-SQUARE STATISTIC
V. K. Murthy and A. V. Gafarian 7 Jun. 1967 24 p refs
(Contract CPR-11-4191)
(TM-3478/001/00; PB-176529) CFSTI: HC $3.00/MF $0.65

Let Pi sub i, i=1x2,....k, be k populations and let the mathematical form of Pi sub i be known except for the unknowns alpha sub 1. Based on random samples ni from populations Pi sub i, i = 1,2,...k, let the hypothesis H sub 0: Pi sub 1 = Pi sub 2 = ... = Pi sub k be tested and accepted. Let alpha prime superscript (N) and alpha star superscript (N) be respectively the modified minimum chi squared and maximum likelihood estimates of sq alpha = alpha sub 1 = ...alpha sub k based on the pooled sample of size N = n1 + n2 + ... + nk. Let Pi Prime and Pi star denote respectively Pi (alpha prime superscript (N)) and Pi (alpha star superscript (N)). The hypotheses H sub 01: Pi sub i = Pi prime and H sub 02: Pi sub i = Pi star are considered for any specified i. This paper shows

that the statistics for testing respectively H01 and H02 do not have the usual limiting chi squared-distribution, but are stochastically larger than would be expected under the chi squared theory. The case when the ni are random variables is being investigated. The application of these results will be reported elsewhere. TAB

20 METEOROLOGY

Includes climatology; weather forecasting; and visibility studies. For related information see also: 13 Geophysics; and 30 Space Sciences.

N68-18285# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.

A COMPARISON OF SIMULTANEOUS WIND PROFILES DERIVED FROM SMOOTH AND ROUGHENED SPHERES

Laurence J. Rider and Manuel Armendariz Sep. 1967 24 p refs

(ECOM-5156; AD-664114) CFSTI: HC$3.00/MF$0.65

Wind profiles plotted from data obtained by tracking Jimspheres (rough surface) and smooth 100-gram spherical balloons released at a common point simultaneously are presented. High precision cinetheodolites were utilized to track the balloons. The computed wind shears for various thickness layers were greater when using data from the smooth balloon. The relationship between the magnitude of the mean vector shears and the shear interval (delta h) assumes a power law with the exponent varying from near one fourth to two thirds depending upon the sensitivity of sensor used and also the height above the surface. Author (TAB)

N68-18286# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.

A HIGH RESOLUTION CONTINUOUS PRESSURE SENSOR MODIFICATION FOR RADIOSONDES

Roy I. Glass, Roy L. Lamberth, and Ralph D. Reynolds Aug. 1967 17 p refs

(ECOM-5145; AD-664113) CFSTI: HC$3.00/MF$0.65

The paper describes how continuous pressure measurements may be obtained by making a relatively simple modification to any standard or clock-switched radiosonde which can be flown on a rising or floating balloon. The continuous pressure device is composed of an aneroid sensor which controls the frequency of a subcarrier oscillator. Frequency modulation of the radiosonde transmitting tube is used instead of amplitude modulation. The receiver for this system utilizes the standard GMD-1B ground tracker with a special demodulator, the standard TMQ-5 recorder, and a frequency counter with printer. Each pressure sensor is calibrated for frequency versus pressure; precision of reading the pressure is to one millibar as currently used but readings to 0.1 mb are easily obtainable. Pressure data from three superpressure balloon flights are presented to show the detail obtained by the instrument with this modification. This modified instrument provides the research meteorologist with a new inexpensive research tool. Author (TAB)

N68-18287# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.

MOUNTAIN WAVE THEORY VS FIELD TEST MEASUREMENTS

Ralph D. Reynolds, Roy L. Lamberth, and Morton G. Wurtele (Calif. Univ., Los Angeles) Sep. 1967 37 p refs

(ECOM-5157; AD-664115) CFSTI: HC$3.00/MF$0.65

Mountain lee wave theories that currently exist do not give the definitive prediction of wavelengths and vertical velocities that is needed on the micro-meso scale for application in ballistic impact prediction at White Sands Missile Range, New Mexico. This is discussed by contrasting several theories with specific field test measurements. The need for improved theories is stressed. Preliminary results for the detection of mountain waves using lidar are presented. Author (TAB)

N68-18313# Emmanuel Coll., Boston, Mass. Research Language Center.

AN INVESTIGATION ON THE PREDICTION OF STRONG WINDS ASSOCIATED WITH COLD FRONTS IN THE YUPEH REGION (NORTHERN HONAN) IN SPRING

Zhong-Ji Zhu, Xue-Mei, and Zeng-Fu Chen Bedford, Mass. AFCRL Sep. 1967 29 p Transl. into ENGLISH from Ch'i Hsiang Hsueh Pao (Peking), v. 35, no. 2, May 1965 p 138–147

(Contract AF 19(628)-5073)

(EMM-66-140; AD-664063)

This paper presents an analysis of the occurrence of strong winds over the region of Kaifeng, Chengchow and Hsinhsiang in Honan Province with respect to orographic conditions. The effect of pressure gradient, the characteristics of the low-level frontal zone and the turbulent exchange on wind speed and the relationship between the flow pattern ahead of the front and the wind speed behind it were also discussed. The synoptic situations associated with the occurrence of strong winds accompanying a cold front over the Yupeh region were classified into three main types, W, N and E, and other subsidiary categories on the basis of synoptic climatology and the trajectories of the cold air. The characteristics of each type of strong winds and the evolution of the associated synoptic process were studied in detail for the formulation of an empirical method to forecast the occurrence of strong winds. The method evolved was then tested for the region under operational conditions during March–May 1964, and the accuracies were found to be 87.5% for type W, 91.7% for type N and 40% for type E. TAB

N68-18391# Litton Systems, Inc., Minneapolis, Minn. Applied Science Div.

FEASIBILITY OF MEASURING VERTICAL ELECTRIC FIELDS IN CUMULUS CLOUDS USING A HOT-AIR BALLOON AND A HELICOPTER Final Report, 3 Jan. 1966–30 Sep. 1967

Arthur L. Handman Dec. 1967 30 p refs

(Contract DA-28-043-AMC-01834(E))

(ASD-3143; ECOM-01834-F; AD-664187)

A hot-air balloon was used but rejected; a helicopter was also used for measuring electric fields in clouds. Dynamic variations of electric field were detected within growing cumulus clouds; these variations are caused by internal advective and convective motions. Because the magnitudes of the field changes are small, a constant redistribution of space charge carried aloft in the updraft is suggested. A recommendation is made that complete electrical evaluation of cumulus clouds be made: from nucleation to cumulo-nimbus development. A high-performance helicopter should be utilized. Author (TAB)

N68-18404# Emmanuel Coll., Boston, Mass. Oriental Science Lab.

A RADAR ANALYSIS OF HAILSTORMS OVER THE PEKING REGION IN 1964

Run-shang Ge Bedford, Mass. AFCRL Oct. 1967 26 p refs Transl. into ENGLISH from Ch'i Hsiang Hsueh Pao (Peking), v. 36, no. 2, Jun. 1966 p 213–222

(Contract AF 19(628)-5073)

(EMM-67-161; AD-664055)

The paper presents a radar analysis of 12 hailstorms over the Peking region in 1964 with particular emphasis on the four most intense ones. The study was supplemented by surface observations and is mainly concerned with the evolutionary

characteristics of the radar echoes. In addition, the shape and intensity of the echoes from hail clouds, the vertical distribution of the various parameters affecting the reflectivity of radar waves, the hail regions in clouds and the topographical influence on the formation of hailstones are discussed. TAB

N68-18556# Texas Univ., Austin. Antennas and Propagation Lab.

BISTATIC RADAR OBSERVATIONS OF DROP SIZE DISTRIBUTION IN A RAIN SHOWER

M. S. Fowler, A. P. Deam, and A. H. La Grone 17 Nov. 1967 83 p refs

(Contract DA-49-092-ARO-87)

(P-17; AD-664179) CFSTI: HC $3.00/MF $0.65

Simultaneous measurements of the orthogonal components of the signal scattered out of the beam of a vertically looking radar were measured. Two-parameter drop size distribution functions, such as that proposed by Marshall and Palmer, were inferred from the measured data. Drop size distributions were measured at the ground using a drop size distribution meter (disdrometer) for two rain showers. A comparison was made between the radar deduced drop size distribution function and that measured with the drop size distribution meter. Significant differences were noted and discussed. The drop size distribution measured at the surface by the disdrometer was graphically integrated and a theoretical ratio of the orthogonal components of the scattered field determined. This study was made for each drop size distribution obtained for different rain rates. The general slopes of the curves so obtained were found to be in good agreement with a curve determined for assumed Rayleigh scattering. Departures were noted and discussed on the basis of scattering theory. The measurements were found to be well within the limits predicted by scattering theory. Author (TAB)

N68-18776# Chicago Univ., Ill. Dept. of the Geophysical Sciences.

ESTIMATION OF TORNADO WIND SPEED FROM CHARACTERISTIC GROUND MARKS

Tetsuya Fujita, Dorothy L. Bradbury, and Peter G. Black Oct. 1967 24 p refs

(Grant CWB-E-86-67-(G))

(RP-69)

Through a detailed photographic survey of characteristic marks produced by tornadoes passing over open fields these marks have been classified into: captive-debris marks, scratch marks, bounce marks, drift marks, debris marks, and cycloidal suction marks. Of these, the cycloidal suction marks were found to be useful in computing the shape and the rotational rate of those funnels which reached the ground. It was concluded that the suction of a tornado at the ground surface is concentrated at several spots around the funnel. The effect of these suction spots upon the objects up to several inches above the surface is just enough to collect debris toward its center, but it is not strong enough to pick it up. The rotational rate of the suction spots was estimated to be less than 150 mph, which is much slower than was expected earlier. Author

N68-18784*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

AN ANALYSIS OF THE ROUGHNESS LENGTH ASSOCIATED WITH THE NASA 150-METER METEOROLOGICAL TOWER

George H. Fichtl 3 Jan. 1968 27 p refs

(NASA-TM-X-53690) CFSTI: HC $3.00/MF $0.65 CSCL 04B

The surface roughness length at the NASA 150-meter meteorological tower located at KSC is determined as a function of wind direction. The roughness length estimates, which were calculated with wind profile laws consistent with the Monin and Obukhov similarity hypothesis, were determined for thirty-nine wind and temperature profiles. Most of the cases were obtained during the hours of 0700 and 1600 EST, and the duration of each test ranged between one-half to one hour. The mean wind speed data were obtained at the 18- and 30-meter levels, and the mean temperature data were obtained at the 18- and 60-meter levels. For those wind directions θ in the ranges $0^\circ \leq \theta < 150^\circ$, $180^\circ \leq \theta < 240^\circ$, and $300^\circ \leq 360^\circ$ the roughness length is 0.23m; for those wind directions in the ranges $150^\circ \leq \theta < 180^\circ$ and $240^\circ \leq \theta < 300^\circ$, the roughness length has the values 0.51m and 0.65m, respectively. Author

N68-18785# Emmanuel Coll., Boston, Mass. Oriental Science Library.

SOME PROBLEMS ON THE MONSOONS OF EAST ASIA

Yu-hsie Kao et al Bedford, Mass. AFCRL Oct. 1967 224 p refs Transl. into ENGLISH from Acad. Sinica (Peking), no. 5, 1962 p 1–106

(Contract AF 19(628)-5073)

(EMM-66-124; AD-664056) CFSTI: HC $3.00/MF $0.65

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7. MONSOONS IN EAST ASIA IN RELATION TO SYNOPTIC SEASONS S.-y. Hsu and Y.-h. Kao p 205–238 refs (See N68-18792 09-20)

N68-18786# Emmanuel Coll., Boston, Mass. Oriental Science Library.

THE MONSOON PROBLEM

Yu-hsie Kao *In its* Some Probl. on the Monsoons of East Asia Oct. 1967 p 1–30 refs (See N68-18785 09-20)

An overview is presented on the scientific treatment of monsoons over the last three centuries, and attention is centered on the diversity of approach in the research development on the problem since the post-World War 2 years. The differences in viewpoint and methods of treatment by scholars in various countries are assessed and compared with the approach used in the study. Based on an analysis of the summer and winter isobaric patterns at various levels over East Asia and the patterns of their seasonal changes, the following characteristics are specified for monsoons: (1) There must be significant seasonal changes in the prevailing wind direction or in the pressure patterns. (2) The seasonal variation of wind direction and pressure systems gives rise to marked changes in weather and climate. Hence small seasonal changes in the pressure and flow patterns cannot produce significant variations in the weather and climate. M.G.J.

N68-18787# Emmanuel Coll., Boston, Mass. Oriental Science Library.

A DISCUSSION ON THE FORMATION OF MONSOON CLIMATES IN EAST ASIA

Yu-hsie Kao and Chi-yunn Kuo *In its* Some Probl. on the Monsoons of East Asia Oct. 1967 p 31–70 refs (See N68-18785 09-20)

Consideration is given to the phenomena of monsoon formation which is attributed to the combined effects of differential heating, topography of the Asiatic mainland, and the planetary wind systems produced by the thermal gradients between the equator and the poles. Interest is focused on the seasonal migration of the planetary wind belts with reference to the formation of monsoons over East Asia, the absence of planetary wind belts on surface isobaric charts, the possible effects of land–sea temperature contrast, and the effects of land–sea distribution on monsoon formation due to annual pressure variation. The difference in heating between land and sea and its seasonal variation in relation to the establishment and seasonal changes of the pressure field in the lower troposphere is also examined. From the data obtained, the opinion is voiced that the distribution of pressure systems in the steady state is solely dependent on the differential heating over land and sea and that the seasonal variation of this heating difference gives rise to a similar variation in the pressure field. Data are also presented to show that the mechanical and heating effects of the Tibetan Plateau produce many features of the monsoons over East Asia. M.G.J.

N68-18788# Emmanuel Coll. Boston, Mass. Oriental Science Library.

SOME CHARACTERISTICS OF THE MONSOON CLIMATES IN CHINA

Chi-yunn Kuo and Yu-hsie Kao *In its* Some Probl. on the Monsoons of East Asia Oct. 1967 p 71–115 refs (See N68-18785 09-20)

Aspects of the monsoon problem are examined, and it is pointed out that the monsoon circulation is found to contribute much to the evolution of general circulation. Also noted are its pronounced characteristics during the prevalent periods in January and July, and the definite influence exerted on the annual distribution of the isobaric field, the seasonal change of the general circulation, and the structure of the temperature and wind fields in the lower troposphere. Consideration is given to (1) the monsoonal influence on the breakdown of planetary circulation in the lower troposphere, (2) the phase lag in the lower and upper flow patterns of the troposphere during periods of seasonal transition due to intense monsoons, (3) the breakdown of normal distribution of the pressure field in the lower troposphere caused by the intense thermal low of the summer monsoon, (4) the monsoonal influence on the flow pattern over China in the lower troposphere, and (5) the monsoonal influence on the tropospheric temperature field over China. M.G.J.

N68-18789# Emmanuel Coll., Boston, Mass. Oriental Science Library.

MONSOON REGIONS AND REGIONAL CLIMATES IN CHINA

Yu-hsie Kao, Shu-ying Hsu, Chi-yunn Kuo, and Min-lie Chang *In its* Some Probl. on the Monsoons of East Asia Oct. 1967 p 116–148 refs (See N68-18785 09-20)

In order to examine the common characteristics as well as the unique peculiarities associated with the monsoons, an attempt has been made to classify the whole of China into various monsoon regions in terms of the seasonal variations in the pressure, wind, and humidity fields, and other meteorological elements such as precipitation and cloudiness. The climates of these regions are described. Author

N68-18790# Emmanuel Coll., Boston, Mass. Oriental Science Library.

THE ADVANCE AND RETREAT OF MONSOONS IN EAST ASIA IN RELATION TO THE SEASONAL VARIATIONS OF THE WESTERLY CIRCULATIONS

Shu-ying Hsu *In its* Some Probl. on the Monsoons of East Asia Oct. 1967 p 149–181 refs (See N68-18785 09-20)

Data are presented to show that the onset of the southwest monsoon over India is closely related to the abrupt dissolution of the southern branch of the westerly jet. It is also shown that the variations in the monsoon flow in the surface layer, as well as the advance and retreat of the monsoons, are closely related to the seasonal change of the upper westerly circulation. It is noted that during a relatively significant advance or retreat of the monsoons over East Asia, distinct variations occur in the high intensity, the distribution, and the positions of such action centers as the Mongolian High (or Indian Low), and the Aleutian Low (or the Pacific High). The problem is discussed, and the opinion is voiced that the advance and retreat of the monsoons are not only related to the formation, intensity, position, and dissipation of the four action centers over East Asia and the variations in their properties, but are also affected by the several distinct changes in the upper air westerly circulation. M.G.J.

N68-18791# Emmanuel Coll., Boston, Mass. Oriental Science Library.

THE ONSET AND TERMINATION OF THE RAINY SEASON IN RELATION TO THE ADVANCE AND RETREAT OF THE MONSOONS IN EAST ASIA

Yu-hsie Kao and Shu-ying Hsu *In its* Some Probl. on the Monsoons of East Asia Oct. 1967 p 182–204 refs (See N68-18785 09-20)

From a study of the seasonal displacement of the mean pentad rain belt (which is the axis of isohyet maximum of mean pentad rainfall), the dates of onset and termination of the rainy season over the various regions in China are defined. Their relationship with the advance and retreat of the monsoons is also examined. Due to the lack of homogeneity in the period of data analyzed, certain inconsistency in the movement of the rain belt is observed. However, the general tendency of the displacement of this system is closely related to the activities of the monsoons. Author

N68-18792# Emmanuel Coll., Boston, Mass. Oriental Science Library.

MONSOONS IN EAST ASIA IN RELATION TO SYNOPTIC SEASONS

Shu-ying Hsu and Yu-hsie Kao *In its* Some Probl. on the Monsoons of East Asia Oct. 1967 p 205–238 refs (See N68-18785 09-20)

The climate of East China is classified into seven synoptic seasons in accordance with the several stages of the advance and retreat of the monsoons and the evolutionary characteristics of the action centers and the westerly circulation. These seasons are deep winter, late winter, spring, early summer, high summer, autumn, and early winter. The characteristic distribution of temperature and precipitation in each season is described. It is pointed out that the advance of the monsoons over China may be divided into several distinct stages, with the onset of each stage manifested by sudden changes in the various meteorological elements. Therefore, each stage is considered as a synoptic season by itself. The opinion is offered that as the synoptic season advances abrupt changes in the pressure system occur first at the surface, bringing about marked variations in weather and climate, but a relatively stable period is reached subsequently. Significant changes in the upper air flow pattern and the westerly wind circulation are also observed concurrently. M.G.J.

N68-19084*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

MEASUREMENTS OF WINDS AND TEMPERATURES AT ALTITUDES UP TO 65 KILOMETERS IN THE SOUTHERN HEMISPHERE

James C. Manning and Lloyd W. Chamberlain (Weather Bur., Wallops Sta., Va.) Washington Mar. 1968 61 p refs (NASA-TN-D-4429) CFSTI: HC $3.00/MF $0.65 CSCL 04B

Meteorological data from 27 rocketsonde and corresponding radiosonde soundings off the west coast of South America are presented as plots of temperature and wind as functions of altitude. The wind data are shown in plots of west-to-east and south-to-north velocity components. Summary time and space cross sections of the data are also shown. Author

N68-19166# National Center for Atmospheric Research, Boulder, Colo.

A CATALOGUE OF METEOROLOGICAL DATA OBTAINED DURING THE LINE ISLANDS EXPERIMENT, FEBRUARY–APRIL 1967

Edward J. Zipser and Ronald C. Taylor (Hawaii Inst. of Geophys.) Jan. 1968 365 p refs Line Isls. Expt. Rept.-1
(NCAR-TN-35; HIG-67-19)

Data collected during the Line Islands experiment is catalogued to provide a comprehensive picture of the oceanic part of the equatorial trough zone, to evaluate cloud photography from the ATS-1 synchronous satellite, and to serve as a pilot program for future experiments in tropical meteorology. Kinds of data collected, dates and frequencies of observations, dates and times of satellite pictures, and obvious limitations of the data are included. Hourly tabulations of most of the surface data parameters, taken between February and April 1967, include wind directions and speeds, moisture parameters, and rainfall data. Summaries of upper air soundings are presented, as are details of various flights, lists of satellite pictures, and a meteorological data guide for the Line Islands. M.W.R.

N68-19169# Joint Publications Research Service, Washington, D. C.

METEOROLOGY

In its Soviet-Bloc Res. Geophys., Astronomy and Space, No. 176 20 Mar. 1968 p 9–32 refs (See N68-19167 09-13)

Meteorological news and scientific research studies are concerned with weather forecasting, wind characteristics and direction, climate and temperature. A computer program for processing wind and temperature data is noted, as is the use of computers for processing cloud data and the use of punched cards and mechanical processing for hydrological data. Abstracted articles deal with Arctic effect on summer temperatures in the U.S.S.R., clouds suited for artificial seeding, heat and water balances, and weather in relation to wind direction. Clear air turbulence over the U.S.S.R., local coefficients of capture of aqueous aerosols, and the microstructure of hygroscopic smokes are reported. M.W.R.

N68-19380# Comision Nacional de Investigaciones Espaciales, Buenos Aires (Argentina).

THE REVERSAL OF THE STRATOSPHERIC CIRCULATION OVER CHAMICAL DURING THE SPRING OF 1966

E. R. Lichtenstein (Natl. Meteorol. Serv., Arg.), V. R. Barros (Natl. Meteorol. Serv., Arg.), and M. W. Vargas (Natl. Meteorol. Serv., Arg.) 1967 21 p refs
(CNIE-PE-12)

During the spring of 1966, weekly rocket soundings were scheduled at Chamical, which made it possible to study (for the first time) the seasonal change of the stratospheric circulation between 30 and 60 km in the Southern Hemisphere at 30 degrees of latitude. Although the temperature measurements were too scarce to be conclusive, the wind profiles revealed the pattern of the seasonal change. At the same time, a strong winter perturbation is mentioned, and a comparison is made with the Northern Hemisphere. Author

N68-19454# Environmental Science Services Administration, Silver Spring, Md.

SECONDARY BIBLIOGRAPHY ON THE CLIMATE OF EQUADOR

1967 14 p refs
(WB/BC-24; PB-176744) CFSTI: HC $3.00/MF $0.65

A bibliography of 80 references is listed. Author

N68-19455# Environmental Science Services Administration, Silver Spring, Md.

BIBLIOGRAPHY ON THE CLIMATE OF BELGIAN CONGO

1967 46 p refs
(WB/BC-11; PB-176731) CFSTI: HC $3.00/MF $0.65

A bibliography of 145 references is given plus an additional 13 items on the organization and history of meteorological networks. Author

N68-19460# Massachusetts Inst. of Tech., Cambridge. Planetary Circulations Project.

THE RADIATIVE HEAT BUDGET OF THE TROPOSPHERE AND LOWER STRATOSPHERE

Clive D. Rodgers (Oxford Univ.) 1 Oct. 1967 104 p refs
(Grant NSF GA-400)
(A2; PB-176527) CFSTI: HC $3.00/MF $0.65

The radiative energy budget of the atmosphere is calculated for the region 0–70 degrees N, 1000–10 mb, for the months of January, April, July and October. The temperature and water vapor profiles are from MIT General Circulation Data Library, the ozone profiles are from the North American ozone network, and the cloudiness data from London (1957). The thermal cooling is also given in a simple matrix form, linearised in terms of temperature deviation from the mean meridional temperature profile. Author

N68-19484# Weather Bureau, Salt Lake City, Utah. Western Region.

VERIFICATION OF OPERATIONAL PROBABILITY OF PRECIPITATION FORECASTS Technical Memorandum, Apr. 1966–Mar. 1967

W. W. Dickey Oct. 1967 29 p
(WBTM-WR-25; PB-176240) CFSTI: HC $3.00/MF $0.65

The memorandum summarizes the verification of a portion of the probability-of-precipitation forecasts issued to the public during the first full year, April 1966–March 1967, of such forecasts in the Western Region. The forecasts verified are those issued in the early morning between about 1000Z and 1200Z for the periods 'Today' (1200-0000Z); 'Tonight' (0000Z-1200Z); and 'Tomorrow' (1200-0000Z). The scores presented in this report are for the entire 12 months of forecasts and for each station as a whole except as noted. These statistics, therefore, give an overall picture of how probability forecasting is going, but give no information on the variations of the scores with season nor on the performance of individual forecasters. The desirability of each forecaster accumulating his own forecasts, computing his own Brier score, and constructing his own reliability table or graph cannot be stressed too strongly. Following these suggested procedures will enable each forecaster to discover his own biases and limitations, improve his own forecasts, and thus raise the level of performance of the station and the Region. Author

21 NAVIGATION

Includes guidance; autopilots; star and planet tracking; inertial platforms; and air traffic control. For related information see also: 07 Communications.

N68-18288# Federal Aviation Administration, Oklahoma City, Okla. Aeronautical Center.
MAINTAINABILITY CONCEPT DEVELOPMENTS FOR CATEGORY 2 LANDING SYSTEMS
James L. Hemingway 9 Nov. 1967 11 p
(AD-664388)

The report discusses the airborne and ground ILS system, a little about CAT II airport lighting equipment, facility monitoring, maintenance time limitations and FAA surveillance. There is a lot of guidance equipment used and required in the airplane for CAT II operations - altimeters, airspeed, vertical speed, attitude, direction, communications, autopilot, approach coupler, flight director, warning systems, automatic throttle, etc. A discussion is given in general terms on how the FAA maintains the integrity of its equipment.
TAB

N68-18476# Federal Aviation Agency, Atlantic City, N. J. Dept. of Transportation.
WEATHER EFFECTS ON VORTAC FACILITIES VOR MONITOR DETECTOR TESTS Final Report
Jack A. Muller Dec. 1967 34 p
(NA-67-10; FAA-RD-66-86; AD-664491)

On this phase of the project the effects of various ice and/or snow conditions on four different monitor detectors, with five different detector covers, were investigated to determine action to be taken in the field to eliminate or reduce VOR outages. Tests were conducted at the NAFEC Experimental VORTAC and the NAFEC Environmental Laboratory. Field and laboratory test results are given.
Author (TAB)

N68-18484*# Stanford Research Inst., Menlo Park, Calif.
STUDY AND APPLICATIONS OF RETRODIRECTIVE AND SELF ADAPTIVE ELECTROMAGNETIC-WAVE PHASE CONTROLS TO A MARS PROBE
C. A. Hacking, R. B. Battelle, C. H. Dawson, R. C. Kunzelman, J. A. Martin et al Washington NASA Mar. 1968 231 p refs
(Contract NAS2-2933)
(NASA-CR-977) CFSTI: HC $3.00/MF $0.65 CSCL 17B

A theoretical study has been made of several aspects of communication by means of adaptive antenna techniques, from the earth to an interplanetary vehicle (bus), and between the bus and a smaller vehicle (capsule) launched from the bus to land on a planet. The study has been restricted to some of the antenna problems associated with such a communication system, particularly where the vehicle is spin-stabilized. The environment to be expected near a planet, particularly Mars, and its effects on the operation of an adaptive system is discussed in some detail. Consideration is given to the various phenomena associated with atmospheric entry, including plasma, atmospheric inhomogeneities, voltage breakdown, and so forth. Four separate antenna configurations that might be suitable for use on a spinning vehicle were investigated theoretically. Particular attention was paid to the retrodirective mode of operation. Several computer programs were written to analyze various aspects of these antennas. It is shown that the effect of spectral splitting can probably be made negligible by careful design of the antenna and adaptive circuitry.
Author

N68-18666# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
TERMINAL GUIDANCE OF AN AIR-TO-SURFACE MISSILE USING OPTIMAL CONTROL AND FILTERING
Michael J. Breza (M.S. Thesis) Jun. 1967 36 p refs
(GGC/EE/67-2; AD-664336)

The optimal control of an air-to-surface missile is determined for a criterion with an integral quadratic weighting of state and control plus a quadratic weighting of terminal state. The controller is then simulated with the nonlinear equations of motion. The control law is capable of correcting errors in both translational and angular position which are determined relative to a nominal path. A Kalman filter is then employed to smooth the state signals which are corrupted by white noise. Representative values of noise, which characterize a range of optical seekers, are used. Greatly improved performance is obtained.
Author (TAB)

N68-18726*# Philco-Ford Corp., Palo Alto, Calif. Space and Reentry Systems Div.
EFFECTS OF BIAS ERRORS ON INTERPLANETARY NAVIGATION AND GUIDANCE SYSTEM PERFORMANCE
Paul J. Rohde 11 Aug. 1967 168 p refs
(Contract NAS8-20358)
(NASA-CR-61599; SRS-TR-148) CFSTI: HC $3.00/MF $0.65 CSCL 17G

The study has analyzed the influence of bias error sources on the navigation and guidance requirements for a round-trip Mars mission. The equation of motion bias errors considered are: (1) astronomical unit conversion, (2) solar-radiation pressure, (3) Mars' planetary mass, and (4) Earth's planetary mass. The measurement bias errors considered are sextant angle measurement bias, and onboard clock bias. The navigation system used in the analysis consists of a sextant with a 10 arc second accuracy. The measurement data are processed with a Kalman filter. The theoretical analysis of the effect of bias error sources on the estimation process is presented. An analysis is presented that shows the error introduced in an estimation process due to neglecting both equation of motion and measurement bias error sources in the modeling of the physical process. A second analysis shows the capability of separating the effects due to bias error sources from those due to random errors. Finally, techniques are presented for efficient parametric analysis by means of matrix manipulations.
Author

N68-18730*# Massachusetts Inst. of Tech., Cambridge. Experimental Astronomy Lab.
SIMPLIFIED MIDCOURSE GUIDANCE TECHNIQUES
Gary L. Slater and Robert G. Stern Feb. 1966 16 p refs Presented at the AIAA Natl. Meeting, Baltimore, Md., 3 Mar. 1966 Submitted for publication
(Grant NsG-254-62)
(NASA-CR-70791; RE-18) CFSTI: HC $3.00/MF $0.65 CSCL 22C

Several techniques for midcourse guidance are explained and compared. They involve simplifying assumptions which materially reduce the amount of on-board computation required to determine a midcourse velocity correction. There are two basic types of simplification. The first involves linearization of the vehicle's motion with respect to a precomputed reference trajectory. Techniques utilizing this simplification are known as "implicit" techniques, in contrast with "explicit" techniques, which require no reference trajectory. Implicit techniques require no on-board numerical integration of the equations of motion, whereas explicit techniques do. The second type of simplification involves treating the effects of all disturbing accelerations as a simple perturbation of a Keplerian orbit; the basic assumption made is that the integrated effect of the disturbing accelerations is constant for trajectories that lie close to each other. Numerical results for Earth–Venus and Earth–Mars missions indicate that all of the simplified techniques are effective in reducing the miss distance at destination with very modest increases in total velocity requirement.
Author

N68-18984*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
MOTIVATION FOR RESEARCH IN STABILITY THEORY
C. C. Dearman, Jr. *In its* Astrodyn., Guidance and Control Rev. No. 1 21 Feb. 1968 p 5–8 (See N68-18983 09-30)

An assessment is made of analytical methods to determine the capability of a proposed space vehicle guidance system to guide the vehicle to a desired terminal state from a given initial

state even when the vehicle is subjected to perturbative forces of extreme severity. One problem encountered is that of finding the maximal region surrounding and containing the unperturbed trajectory from any point within which the vehicle may be guided to the desired terminal state within a specified time interval. The problem is discussed in relation to the finite-time intervals and modification of the classical theory. It is concluded that the necessary theories for investigating problems in finite-time stability are available, and that practical methods for generating Liapunov functions are needed in order to make positive statements about the stability of a nonlinear system and to find its domain of stability. Also it is important to know the relations among the concepts of optimality, stability and sensitivity so that tools for testing and developing guidance and control systems are optimal, reliable, and capable. B.S.D.

N68-18985*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
RESEARCH IN STABILITY AND CONTROL THEORY
R. W. Gunderson *In its* Astrodyn., Guidance and Control Rev. No. 1 21 Feb. 1968 p 9–10 (See N68-18983 09-30)

In order to further research in stability and control theory, efforts centered on analytical techniques which can be used to replace costly experimental procedures now used in the development of launch vehicle and spacecraft guidance and control systems. The efforts are divided into four areas: (1) the theory of differential equations, (2) linear systems theory, (3) nonlinear systems theory, and (4) application of these various techniques. An example of the work being carried out in each of these areas is given along with a brief summary of the current efforts. B.S.D.

N68-18987*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
GUIDANCE TECHNIQUES FOR INTERPLANETARY FLIGHT
Wilton E. Causey *In its* Astrodyn., Guidance and Control Rev. No. 1 21 Feb. 1968 p 19–22 (See N68-18983 09-30)

The three phases of interplanetary flight which require guidance are delineated, and certain characteristics which the guidance schemes must have are discussed. The injection guidance scheme for interplanetary flight should (1) be near optimal in order to take full advantage of the performance of the launch vehicle, (2) produce accurate infection conditions so that midcourse maneuvers can be kept small, and (3) be flexible in order to handle in-flight perturbations. In order to establish a more exact terminal orbit about the target planet, the guidance scheme for making midcourse maneuvers should stress accuracy and simplicity. Accuracy is also important in terminal guidance in that capsule landing sites, orbital photography, and other scientific experiments are affected by the terminal orbit's size and orientation. B.S.D.

N68-18988*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
THE MATHEMATICAL AND NUMERICAL ANALYSIS ASSOCIATED WITH OPTIMAL GUIDANCE CONCEPTS
Hugo Ingram *In its* Astrodyn., Guidance and Control Rev. No. 1 21 Feb. 1968 p 23–26 (See N68-18983 09-30)

The operation of a guidance system is discussed in relation to three distinct divisions of effort which are: (1) the navigation part for determining the vehicle's present conditions or state, (2) guidance signal generator for knowledge of vehicle's total state and knowledge of the desired destination to determine how to steer, and (3) the control dynamics which result from an implementation of the guidance. Consideration is also given to an onboard guidance system which performs the mathematical computations necessary for proper operation. Optimal guidance of a vehicle is considered with respect to a set of ordinary differential equations used to simulate mathematically the motion of the vehicle. Some general ideas about the mathematical and numerical analysis involved in optimization problems are discussed, and the mathematical and numerical aspects needed in the solution of optimization problems are summarized. B.S.D.

N68-18990*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
ANALYTICAL SOLUTION OF OPTIMAL GUIDANCE PROBLEMS
Rowland E. Burns *In its* Astrodyn., Guidance and Control Rev. No. 1 21 Feb. 1968 p 31–33 (See N68-18983 09-30)

Consideration is given to the solution of a set of differential equations which govern the motion of a vehicle assumed to be flying in vacuuo in a uniform gravitational field. It is pointed out that an analytical solution means an expression which relates the velocity or position with the time, steering angle, and initial conditions by means of elementary functions. These analytic solutions are desirable because algebraic equations are more readily handled by computers than are differential equations. Equations of rocket motion in the case of constant thrust are also discussed. The problem involves specifying the guidance system from a set of six differential equations to a set of three differential equations. Work is now concerned with a transformation of the variables appearing in these algebraic equations to new variables in such a way that the reduction from six differential equations to three differential equations will be possible. B.S.D.

N68-19046*# National Aeronautics and Space Administration, Washington, D. C.
SPACE NAVIGATION
Dec. 1967 8 p
(NASA Facts-NF-37) GPO: HC $0.10 CFSTI: MF $0.65 CSCL 22C

This educational facts pamphlet contains a comprehensive summary of the history and problems of space navigation. Discussed are solar orbits, planetary motion, earth–planet trajectories, course alterations, sextant measurements, guidance of unmanned spacecraft, navigation equipment, Apollo spacecraft navigation, and the work of early astronomers. K.W.

N68-19061*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
SATURN 5 MANUAL BACKUP GUIDANCE AND CONTROL PILOTED SIMULATION STUDY
Richard L. Kurkowski and Gordon H. Hardy Washington Mar. 1968 29 p refs
(NASA-TN-D-4481) CFSTI: HC $3.00/MF $0.65 CSCL 17G

Fixed base simulation studies of manual backup guidance and control for the Saturn V have been conducted. A manual attitude trim control system was devised using the spacecraft inertial platform and command module computer to provide a backup attitude control loop. The guidance loop was provided by the pilot who observed digital displays of trajectory parameters, compared them with nominal values, and input controller commands to bias vehicle attitude. Another backup system called the rate command system fed the pilot controller commands directly to the launch vehicle where they were summed with the launch vehicle rate gyro output. The two backup systems were evaluated first for upper stage guidance and control, from second stage ignition to earth orbit injection. The results indicate that either system could be used effectively to guide the vehicle into earth orbit. Evaluation of these two systems for the first stage flight showed that the rate command system was not suitable because the direct on–off signal from the controller adversely affected the sloshing and bending dynamics of the vehicle. The attitude trim system, however, was suitable for first stage control. Author

N68-19163*# Philco-Ford Corp., Palo Alto, Calif. Space and Re-Entry Systems Div.
ESTIMATION OF INERTIAL PLATFORM ERRORS
John V. Brown and James S. Tyler, Jr. 21 Oct. 1967 117 p refs
(Contract NAS8-20358)
(NASA-CR-61645; TR-DA-1569) CFSTI: HC $3.00/MF $0.65 CSCL 17G

Equations are derived for an inertial platform error model, including those for minimum variance estimations and tracking; and the dynamic equation of the vehicle is presented in a study that combines telemetry and tracking to estimate either the trajectory of the error parameters that affect trajectory. Preliminary results are concerned mainly with the individual error sources in both the guidance and tracking systems; with the most important error sources are found to be the platform misalignments, the gyro drifts, the accelerometer biases, and some of the accelerometer misalignments and scale factor errors. The significant errors in the C-band radar included random and measurement bias errors in range, azimuth and elevation, and station location. In addition to the random tracking errors, 34 bias errors were included in the final model. Feasibility of estimating the platform error sources is shown both for updating the guidance system during a flight and for a post-flight analysis. For the tracking model used in this study, it is concluded that the Saturn V type of inertial platform errors are so small that it is impossible to significantly reduce uncertainties of error sources during powered flight. M.W.R.

N68-19164*# Honeywell, Inc., St. Petersburg, Fla. Aerospace Div.
CENTAUR IN RETROSPECT: A TECHNICAL SURVEY OF THE CENTAUR INERTIAL GUIDANCE SYSTEM EVOLUTION FROM 1959 TO 1967
Jan. 1968 781 p
(Contract NAS12-587)
(NASA-CR-86040; Honeywell-R-ED-27290) CFSTI: HC $3.00/MF $0.65 CSCL 17G

A technical design survey discusses the accomplishments and problems; successes and failures; and design requirements, alternatives, and tradeoffs which led to decisions relating to the evolution and application of the Centaur inertial guidance system. Following a chronological and descriptive introduction for the overall system, details are presented for the inertial measuring unit, computer equipment, and activation and vehicle interface. Control and display for both the system and the computer ground support equipment are discussed, and details of the guidance and control system are included. Through this manual, new concepts and major design changes are noted, recommendations for future research are made, and cross referencing between related topics in the text is made. M.W.R.

N68-19236*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
SIMPLE PROCESSORS OF STAR TRACKER COMMANDS FOR STABILIZING AN INERTIALLY ORIENTED SATELLITE
Robert D. Showman, Brian F. Doolin, and G. Michael Sullivan Washington Mar. 1968 66 p refs
(NASA-TN-D-4490) CFSTI: HC $3.00/MF $0.65 CSCL 17G

The study develops processors which convert star tracker gimbal angle measurements to satellite attitude control signals. An exact processor is nonlinear and complex because the gimbal angles vary as the inertial orientation of the vehicle changes. In this paper, approximations to the exact processor are developed which greatly simplify the mechanization and yet allow satisfactory attitude control. Three approximate processors are derived from a perturbation analysis in which only the first-order terms are considered significant. The use of the three processors to derive attitude control signals for an example satellite such as the Orbiting Astronomical Observatory is investigated. Author

N68-19302# Airborne Instruments Lab., Deer Park, N. Y.
PRECISION VOR. VOLUME 1: DEVELOPMENT AND FLIGHT TEST PROGRAM
E. Hollm, R. Mesard, and M. Zeltser Aug. 1967 45 p ref
(Contract FA-65-WA-1058)
(RD-67-58, V. 1)

The operating specifications (modulation percentages, tolerances, bandwidth, etc.) of the precision multilobe VOT [PVOR(M)] are established. The criteria for selection of monitor field-detector positions and monitor tolerances are explained, and the flight/test computer program used to establish them is described. A simplified broad-band PVOR(M)/Doppler-VOR feed system to replace the feasibility-model PVOR(M) feed system was developed during this program. Author

N68-19303# Federal Aviation Agency, Atlantic City, N. J. National Aviation Facilities Experimental Center.
FLIGHT SIMULATION STUDY OF AIR-TO-AIR RANGING DISPLAYS FOR SEPARATION ASSURANCE Interim Report
Roman M. Spangler and Richard L. Sulzer Feb. 1968 27 p
(NA-68-13; RD-66-83)

Three flight simulation tests have assessed the operational value for separation assurance of cockpit display of: (a) warning that another aircraft has intruded within 60 miles, plus constant display of intruder range; (b) the same warning and present range, plus pilot-to-pilot communications; and (c) the warning and present range, plus relative bearing of the intruder, without communications. All three added displays were adequate for overtaking intrusions with no one method very superior to the others. Head-on and beam intrusions produced less assurance. Potentially serious errors of interpretation occurred with all three displays in high closure rate head-ons. Author

N68-19372# Federal Aviation Administration, Atlantic City, N. J.
SIMULATION AND ANALYSIS OF OVER OCEAN SEPARATION ASSURANCE PROCEDURES AND DISPLAYS Final Report
Warren G. Crook and Richard L. Sulzer Feb. 1968 76 p refs
(NA-68-14; RD-67-43)

After an analysis of operational characteristics in North Atlantic air traffic and the air traffic control system, standard operating procedures (SOP) for pilot use of air-derived separation information were developed and tested in flight simulators. Three individual system types were simulated: air-to-air distance measuring equipment, airborne beacon range/altitude monitor, and airborne time/frequency range/altitude monitor. The capabilities and limitations of each system display and pilot preferences were determined through exercise in a wide diversity of aircraft intrusion situations. Horizontal and vertical evasive maneuvers were employed in all the test runs which included slow and fast closing, as well as head-on encounters. Altitude probing before a vertical maneuver was tested. With immediate and assured communications, and with the tested SOP, the displays were all adequate to insure separation. Pilot preferences were for the simplest displays and controls. Author

N68-19428*# National Aeronautics and Space Administration, Washington, D. C.
APPLICATIONS FOR INERTIAL SENSORS IN SPACE
Jules Ranter 1968 12 p Presented at the Inst. of Navigation, Boston, 21 Apr. 1968
(NASA-TM-X-57531) CFSTI: HC $3.00/MF $0.65 CSCL 17G

Various launch vehicle and spacecraft applications of the inertial sensor, either as part of an inertial guidance platform system or as a sensor for attitude reference and control from an on-board programmer or ground-based command, are discussed along with the options available and the improvements needed. R.N.A.

22 NUCLEAR ENGINEERING

Includes nuclear reactors and nuclear heat sources used for propulsion and auxiliary power. For basic research see: 24 Physics, Atomic, Molecular, and Nuclear. For related information see also: 03 Auxiliary Systems; and 28 Propulsion Systems.

N68-18384# Atomic Energy Commission, Washington, D. C. Div. of Industrial Participation.
THE NUCLEAR INDUSTRY
1967 184 p Presented at the Atomic Indus. Forum's Ann. Conf., Chicago, 6 Nov. 1967
(TID-24102; CONF-671115-1) GPO: $1.00

The peaceful application of nuclear energy that has the most impact on the U.S. economy is that of nuclear reactors to produce steam for generation of electric power. The volume of orders for nuclear-electric generating units for 1966 is compared with that for nine months of 1967. Other applications of nuclear energy are associated with desalting water, providing electric power for space and the ocean bottom, commercial explosives, preserving food, and producing new wood–plastic products. NSA

N68-18463# Oak Ridge National Lab., Tenn. Reactor Div.
HFIR FUEL ELEMENT STEADY STATE HEAT TRANSFER ANALYSIS
Howard A. McLain Dec. 1967 204 p refs Revised
(Contract W-7405-ENG-26)
(ORNL-TM-1904) CFSTI: HC $3.00/MF $0.65

The steady state heat transfer analysis of the HFIR fuel elements was completely rewritten using new information regarding the thermal deflections of the fuel plates. This analysis uses an integral thermal-hydraulic model which simultaneously accounts for the nuclear, hydraulic, heat transfer, mechanical, and the corrosion history of the operator reactor. It shows that the design requirements for the HFIR fuel elements have been met. Imposing the criteria of no boiling in the fuel elements, the upper limit for the power at startup is 139 Mw and that at the end of a 25 day 100 Mw fuel cycle is 153 Mw. Author (NSA)

N68-18530# Los Alamos Scientific Lab., N. Mex.
COATED PARTICLE FUELS: THERMAL, MECHANICAL, AND STRESS PROPERTIES. A BIBLIOGRAPHY
Jean Furnish, comp. 30 Nov. 1967 20 p refs
(Contract W-7405-ENG-36)
(LA-3791) CFSTI: HC $3.00/MF $0.65

A bibliography on coated particle fuels from 1964–1967 is presented. Mechanical and thermal properties of uranium materials are the primary area of interest; interaction of the fuels with their matrix is also considered. NSA

N68-18534# European Atomic Energy Community, Ispra (Italy).
SPECTRUM INDICES MEASUREMENTS IN ORGEL TYPE UC CLUSTER FUEL ELEMENTS
F. Conti Brussels Jan. 1968 40 p refs
(EUR-3736.E) CFSTI: HC $3.00/MF $0.65

Results of index spectrum measurements performed in natural uranium carbide cluster type fuel elements are described. Both the epithermal and the thermal spectrum indices were determined by means of integral activation techniques, using foil detectors with resonances, respectively in the epithermal and maxwellian regions. The resonance activities are normalized to that of a 1/v detector. The activity ratios are interpreted with the aid of the Westcott's convention. Author

N68-18541*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
DETERMINATION OF INTERSECTION OF PARTICLE FLIGHT PATH WITH SURFACE OF HELICAL TUBULAR VOID REGION
Millard L. Wohl and Carl D. Bogart Washington Mar. 1968 25 p refs
(NASA-TN-D-4435) CFSTI: HC $3.00/MF $0.65 CSCL 18F

A method for determining the intersections of a nuclear particle flight path and the wall of a helical tubular duct is presented. FORTRAN listings of computer subroutines which perform the numerical analysis involved are included. The subroutines are useful in any Monte Carlo transport analysis where complex void configurations of helical or pseudohelical geometry are involved. Their immediate purpose in this work is to serve as geometry subroutines to be used in conjunction with 05-R, a Monte Carlo transport code. Author

N68-18550# Gosudarstvennyi Komitet po Ispolzovaniyu Atomnoi Energii, Moscow (USSR). Institut Teoreticheskoi i Eksperimental'noi Fiziki.
CALCULATION OF HEAT RELEASE IN CYLINDRICAL FUEL ELEMENTS [RASCHET TEPLOVYDELENIYA V TSILINDRICHESKIKH BLOKAKH]
V. M. Mikhailov 1966 47 p refs In RUSSIAN; ENGLISH summary
(ITEF-455)

The quantity of energy produced in the cylindrical fuel element with homogeneous distribution of fuel material as well as its radial dependence is calculated. It is shown that the distributions of radiation flux and fast neutron fission density can produce a deviation of the radial dependence of the total energy production from that one which is proportional to the thermal neutron flux. This deviation can be of such an extent that at some cases it should be taken into account in thermal engineering calculations. Author (NSA)

N68-18557# Nuclear Materials and Equipment Corp., Apollo, Pa.
DEVELOPMENT AND TESTING OF PuO_2–UO_2 FAST REACTOR FUELS Progress Report, 1 Jul.–30 Sep. 1967
Oct. 1967 25 p
(Contract AT(30-1)-3524)
(NUMEC-3524-43) CFSTI: HC $3.00/MF $0.65

A method of density control for ceramic fuels is described which consists of adding a quantity of the fuel precursor to the ceramic fuel powder in the blending-prior-to-pressing step and firing in the normal sintering cycle. Test results using 5 to 20% fuel precursor of $Pu(OH)_2$–ADU are presented. Determination of homogeneity by autoradiography for fuel consisting of 2 and 3 wt % of 100μ PuO_2 microspheres blended with the base oxide of 20% PuO_2–UO_2 is described. Transverse section autoradiograph results of the mixing procedures are presented. NSA

N68-18563# Minnesota Mining and Mfg. Co., St. Paul, Minn. Isotope Power Lab.
SNAP-23A PROGRAM POST TEST ANALYSIS PLAN AND REPORT. VOLUME 2: ANALYSIS REPORT
D. R. Field Nov. 1967 121 p Sponsored by AEC
(MMM-3824-0002, V. 2) CFSTI: HC $3.00/MF $0.65

The post-test analysis, observations, results, and conclusions drawn from the operation of the SNAP-2, 3 six-couple Module A-2 and 252-couple prototype Converter P-1 are given. The post-test examination was conducted to establish potential failure or degrading mechanisms within the converter and module. Both the converter prototype and the module had anomalies in their thermoelectric performance during testing. Module A-2 had large fluctuations in output power due to a decrease in resistance across the P leg-hot electrode contact regions and due to a decrease in Seebeck voltage for the P legs and an increase in resistance across the N leg-hot electrode contact regions. Converter P-1 operated stably for 10,800 hrs. Higher spring pressure and lower hot electrode

temperatures contributed to the stable performance. Misalignment of the legs within the converter did not affect converter performance. Thermal impedance between the cold caps and cold frame was caused by the inability of the heat transfer grease to maintain good thermal contact between the cold caps and followers. A Ni coating appears to restrict Cu migration into the cold segment material. NSA

N68-18568# Minnesota Mining and Mfg. Co., St. Paul, Minn. Isotope Power Lab.

SNAP-23A PROGRAM POST TEST ANALYSIS PLAN AND REPORT. VOLUME 1: ANALYSIS PLAN

D. R. Field Nov. 1967 49 p Sponsored by AEC
(MMM-3824-0002, V. 1) CFSTI: HC $3.00/MF $0.65

The post-test analysis plan for the SNAP-23 six-couple Module A-2 and 252-couple prototype Converter P-1 is given. All converter components will be inspected and analyzed to determine any change in the thermoelectric materials. Converter P-1 was held at the design temperature throughout the entire test life. Converter P-2 was tested at considerably lower temperatures. Module A-2 experienced large voltage and resistance changes which should be more evident in Module A-2 than in Module A-3. The post-test examination will include quality control data, processing data, and physical, thermoelectric and chemical analysis of residual thermoelectric legs from the same lot and batch used in the converter and module. The inspection and analyses of the converter and module will be conducted on thermoelectric couples and adjacent components. After the pre-test, test, and post-test data are compiled, conclusions and supporting data will be reported. NSA

N68-18727# United Kingdom Atomic Energy Authority, Risley (England).

ATTOW: A TWO DIMENSIONAL SHIELDING PROGRAM

W. D. Collier and G. C. Curtis 1967 60 p refs
(TRG-1466(R)) HMSO: 8s

ATTOW is a shielding code programmed in FORTRAN IV for the IBM 7090 computer. It solves the multi-group diffusion equations in two dimensions for non-multiplying media. Any number of groups is allowed but neutron transfer is only allowed from higher groups to lower. There may be up to 100×100 mesh points over a rectangle within which materials may be mapped out as required. Any distribution of neutron sources can be specified, derived if desired from the built-in removal program. Output includes flux prints, neutron currents and detector activations. This report gives the data requirements in detail, and illustrates the use of the program. The method of solution of the equations is also described. Author

N68-18741# United Kingdom Atomic Energy Authority, Risley (England). Reactor Group.

THE ADSORPTION OF KRYPTON AND XENON FROM ARGON BY ACTIVATED CHARCOAL

D. A. Collins, R. Taylor, and L. R. Taylor 20 Sep. 1967 20 p refs
(TRG-1578(W)) HMSO: 2s 6d

In sodium-cooled fast reactors the argon cover gas may require purification from radioactive krypton and xenon. Coconut-based charcoals have been found to be superior to other types for the adsorption of krypton and xenon from argon. Adsorption coefficients for xenon and krypton have been measured over a wide range of concentrations in argon and the effect of coadsorption of krypton on the adsorption coefficients for xenon has been examined. The effect is not serious at temperatures down to $-70^{\circ}C$ if the krypton concentration in the gas phase is below 1000 v.p.m. Author

N68-18857# Kernforschungszentrum, Karlsruhe (West Germany). Inst. fuer Angewandte Reaktorphysik.

THE BALANCED OSCILLATOR TESTS IN SEFOR

L. Caldarola (EURATOM, Brussels (Belgium)), P. Giordano, M. Audoux, H. Rohrbacher, and C. Russell (GE, San Jose, Calif.) Aug. 1967 56 p refs Prepared in cooperation with EURATOM
(KFK-650; EUR-3686.E) CFSTI: HC $3.00/MF $0.65

Balanced oscillator tests will be performed in the Southwest Experimental Fast Oxide Reactor to measure reactivity coefficients. Two types of tests are planned. In the first, the transfer functions between reactivity and power and between power and coolant flow are measured, while the coolant temperature is kept constant. In the second test, the transfer function between reactivity and coolant temperature is measured, while the reactor power is kept constant. Particular effort was devoted to studying possible ways of obtaining balancing conditions in the reactor plant. Two different types of control are being considered: (1) open loop control in which predetermined input signals will be given to the reactor plant to hold constant the cpolant temperature for the first test and the power for the second test, and (2) closed loop control in which the balance condition (constancy of the coolant temperature for the first test and power for the second test) is reached with the aid of closed loops control. Both control methods are described and their performance characteristics are analyzed. Author

N68-18873# Oak Ridge National Lab., Tenn. Nuclear Safety Information Center.

TECHNOLOGY OF STEEL PRESSURE VESSELS FOR WATER-COOLED NUCLEAR REACTORS: A REVIEW OF CURRENT PRACTICE IN DESIGN, ANALYSIS, MATERIALS, FABRICATION, INSPECTION, AND TEST

G. D. Whitman, ed., G. C. Robinson, Jr., ed., and A. W. Savolainen, ed. Dec. 1967 675 p refs
(Contract W-7405-ENG-26)
(ORNL-NSIC-21) CFSTI: HC $3.00/MF $0.65

The current practices in the design and fabrication of steel pressure vessels for light-water-cooled nuclear reactors in present and immediate-future commercial use are reviewed. The specified service and predicted environmental conditions are identified, along with an evaluation of the effects of these parameters on materials behavior. Materials fabrication and materials properties of interest in pressure-vessel fabrication are reviewed, and the metallurgy of these materials is discussed. The basic aspects of fracture mechanics and crack growth are examined, with emphasis on the low-alloy steels of current interest. The codes and standard applied in the technology are discussed, and areas where augmentation and/or revision to these standards appears warranted are identified. The techniques for postoperational and in-service inspection are summarized and evaluated. Author (NSA)

N68-18877# Oak Ridge National Lab., Tenn. General Engineering Div.

STRUCTURAL ANALYSIS OF THE BROOKHAVEN NATIONAL LABORATORY SHIPBOARD IRRADIATOR

J. H. Evans Jan. 1968 82 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-2064) CFSTI: HC $3.00/MF $0.65

The methods of evaluating the structural integrity of a container in which radioactive material is shipped to show compliance with the governing regulations are illustrated in this report of the structural analysis performed on the Brookhaven National Laboratory Shipboard Irradiator. Testing methods, calculating procedures, and operating experience were applied in the analysis of the cask with respect to the regulations covering the general standards for packaging, the structural requirements, the normal conditions of transport, and the hypothetical accident conditions. Structural modifications were proposed to eliminate deficiencies in the existing cask, and this analysis demonstrated that with the proposed cask lid, lifting devices, and crash frame, the irradiator complies with all the applicable regulations. Author (NSA)

N68-18879# Japan Atomic Energy Research Inst., Ibaraki.
DESIGN OF PLUTONIUM SELF-SUSTAINING REACTOR, HEAVY WATER MODERATED BOILING LIGHT WATER COOLED
S. Sawai, S. Yasukana, and W. Shinoda Jan. 1968 15 p refs
(JAERI-1151) CFSTI: HC $3.00/MF $0.65

The heavy water moderated power reactor has been studied and the boiling light water cooled type was selected for further development. The study led to the adoption of a Pu self-sustaining cycle. This cycle has the following advantages: it is equivalent to a slightly enriched fuel cycle giving much flexibility in the core design, and it might be said about 15,000 MDW/T of burn-up would be expected with natural uranium by the catalyzer of Pu produced in its own spent fuel. The void coefficient, which influences the stability and safety of this type of reactor, would not be a major problem when loading Pu into the core. When adopting a Pu self-sustaining cycle, however, it should be noted that slightly enriched uranium would be loaded in the initial cycle, which may have a positive void coefficient. The problem will be eliminated to some extent by setting interlattice tubes in the core and taking a lower ratio of moderator to fuel for the U loaded core and a higher ratio of the Pu loaded core. At the same time higher reactor exit steam quality or higher DNB margin would be expected in the Pu loaded than in the U loaded core. On-load refueling is one of the major problems to be solved for the reactor. Two refueling methods were investigated and the corresponding refueling machines were designed. Author

N68-18893# Argonne National Lab., Ill.
REACTOR DEVELOPMENT PROGRAM Progress Report, Sep. 1967
31 Oct. 1967 155 p refs
(Contract W-31-109-ENG-38)
(ANL-7382) CFSTI: HC $3.00/MF $0.65

Technical progress is reported on specific reactor projects and general reactor engineering research and development programs. This period's activities were concerned with plutonium utilization in the experimental boiling water reactor, liquid metal fast breeder reactors, general reactor technology, advanced systems research and development, and nuclear safety. R.N.A.

N68-18897# United Kingdom Atomic Energy Authority, Harwell (England). Research Group.
STABILITY OF FUEL ROD IN A NARROW ANNULAR COOLANT CHANNEL AGAINST THERMAL BUCKLING
J. Woodrow 25 Sep. 1967 22 p refs
(AERE-R-5601) HMSO: 3s

An analysis of the thermal stability of a small transverse distortion of a simply-supported fuel rod is given, which can be applied to all but liquid metal coolants. A third order differential equation governing the bowing of the rod is obtained; a transcendental characteristic equation is then found, which enables the critical output of the reactor to be determined without further approximation. Fuel elements which are held rigidly at the upstream end and free at the other, are inherently stable against thermal buckling. Author

N68-18933# Argonne National Lab., Ill.
STUDY OF HEAT RELEASE DISTRIBUTION IN FAST REACTORS WITH ABSORBER RODS
V. V. Bouddarenko, A. I. Voropaev, V. P. Zinov'ev, B. V. Koloskov, V. P. Polivanskii et al 3 Nov. 1967 13 p refs Presented at Symp. on Fast Reactor Phys. and Related Safety Probl., Karlsruhe, 30 Oct.–3 Nov. 1967
(ANL-TRANS-542; CONF-671043-14) CFSTI: HC $3.00/MF $0.65

The experimental calculation of a fast reactor with a system of absorbing rods in compensation units of burnup to permit increased continuous operation periods is presented. Three assemblies were tested to note effects of configuration on heat fluctuations in the fuel elements. In each assembly the core contained two regions with different concentrations of ^{235}U in the fuel rods, a zone of low enrichment and a zone of high enrichment. The three assembly variations were: homogeneous zones with centrally located boron rods; simulators of control units in "withdrawn" position and one inserted boron rod for a control simulator; and an assembly with a more powerful boron rod to serve as a simulator of the temperature compensator. Author

N68-18939# Oak Ridge National Lab., Tenn.
HIGH FLUX ISOTOPE REACTOR Quarterly Report, Jul.–Sep. 1967
R. V. McCord and B. L. Corbett 13 Nov. 1967 26 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-2078) CFSTI: HC $3.00/MF $0.65

A major problem, breakage of control-plate bearing lugs, was encountered this quarter. The first breaks were noted at the end of cycle 14. Modifications were made to the bearings and their tracks, but additional breaks occurred in cycle 15. Investigation of this problem resulted in only 32.4% reactor operating time this quarter. The primary coolant system was partially decontaminated of its accumulated load of transuranium elements by the addition of $La(NO_3)_3$ to the water. Author (NSA)

N68-18944# Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik.
MUNDO: DIGITAL PROGRAM FOR CALCULATION OF ACCIDENT RATES IN THE ENVIRONMENT OF A REACTOR INSTALLATION [MUNDO: DIGITAL PROGRAMM ZUR BERECHNUNG VON UNFALLDOSEN IN DER UMGEBUNG EINER REAKTORANLAGE]
F. Heller, W. Schikarski, and A. Wickenhaeuser Sep. 1967 37 p refs In GERMAN Sponsored by EURATOM
(KFK-653; EUR-3684.D) CFSTI: HC $3.00/MF $0.65

The MUNDO computer program calculates the accident dosage equivalent at a given time and location as a function of relevant parameters and conditions. The program takes the following into account: fuel release functions and factors, decontamination factors, filter factors, leakage functions, multiple containments, ground release, chimney release, weather conditions, external and internal radiation, and direct radiation from the reactor building. The contributions of approximately 80 fission products and fuel isotopes to the accident dosage can be computed. Physical relations, the mathematical model, the FORTRAN program, input data, source references, and limitations of the program are described. Transl. by K.W.

N68-18957# Kernforschungszentrum, Karlsruhe (West Germany). Inst. fuer Angewandte Reaktorphysik.
THE PRINCIPLE OF DOUBLE CONTAINMENT AND THE BEHAVIOUR OF AEROSOLS IN ITS RELATION TO THE SAFETY OF REACTORS WITH A HIGH PLUTONIUM INVENTORY
W. Haefele, F. Heller, and W. Schikarski Oct. 1967 19 p refs Sponsored by EURATOM
(KFK-669; EUR-3702.E) CFSTI: HC $3.00/MF $0.65

A typical large fast sodium-cooled breeder of 1000 MWe power was used in calculations made to define the interrelations between the containment system, the inventory of radioactive material, and the radiation burden to the environment in case of accident. Particular attention was paid to the release of various fission products and fuel isotopes, such as iodine and plutonium. The influence of the release parameters and the release models, particularly the aerosol model, on the accident doses for typical single and double containment systems is discussed. Accident doses for four different sets of release fractions are given as a function of the containment system leakage. An assessment is also made of the significance of the decontamination of the containment atmosphere either by natural plate-out or by artificial means such

as filter systems. It is concluded that the aerosol model provides more realistic release data for solid materials, and better describes the activity transport after large accidents in fast sodium-cooled breeder reactors. M.G.J.

N68-18960# FIAT S.P.A., Turin (Italy).
SQUID-360—A MULTIGROUP DIFFUSION PROGRAM WITH CRITICALITY SEARCHES FOR THE IBM-360
A. Daneri, B. Gabutti, and E. Salina Brussels Feb. 1968 130 p (Contract EURATOM-089-66-2 TEEI)
(EUR-3882.E) CFSTI: HC$3.00/MF$0.65

SQUID-360 is a multigroup diffusion program in two dimensions (x, y or r, z) written in Fortran IV for the IBM-360/65. The main features of the program are: complete scattering matrix, solution of non-homogeneous problems, solution of adjoint problems, 3 types of criticality searches, and restart of interrupted problems. Author

N68-18986# Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik.
REACTOR TEMPERATURE TRANSIENTS WITH SPATIAL VARIABLES. SECOND PART: AXIAL ANALYSIS
L. Caldarola, W. Niedermeyer, and J. Woit Jul. 1967 136 p refs Sponsored by EURATOM
(KFK-618; EUR-2403.E) CFSTI: HC$3.00/MF$0.65

Coolant temperature transients are analyzed by solving the spatial-time dependent coolant heat balance equation in a reactor channel. Results coming from the analysis of the heat propagation in a fuel element are used. The solution of the equation is obtained by using the Laplace transform method. It has been found out that the coolant transients depend upon 5 parameters. Numerical examples are also included. Author

N68-19004# Babcock and Wilcox Co., Lynchburg, Va. Atomic Energy Div.
FAST BREEDER REACTOR STATIC PHYSICS METHODS DEVELOPMENT AND ANALYSIS PROJECT Quarterly Technical Report, Jul.–Sep. 1967
D. H. Roy Nov. 1967 38 p refs
(Contract AT(30-1)-3867)
(BAW-3867-1) CFSTI: HC$3.00/MF$0.65

The design code FARED is described. The compilation, debugging, and modifications made in the ENDF/B service routines are also described. The one-dimensional criticality and depletion code is used to relate the sensitivity of certain fast reactor design parameters to complex physics models. NSA

N68-19013# Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik.
INVESTIGATIONS OF CHARGES 3 AND 4 OF THE FAST-THERMAL ARGONAUT REACTOR [UNTERSUCHUNGEN AN DEN LADUNGEN 3 UND 4 DES SCHNELL-THERMISCHEN ARGONAUT-REAKTORS STARK]
L. Barleon, Chr. Bruecker, K. Burkart, G. Fieg, D. Kuhn et al Sep. 1967 94 p refs In GERMAN Sponsored by EURATOM
(KFK-668; EUR(-3701.D) CFSTI: HC$3.00/MF$0.65

The calculated neutron spectrum for various radial positions of the STARK nuclear reactor exhibited a weakening of the slow neutron flux during infiltration into the fast reactor zone and a neutron intensity decrease above 20 keV. The spectrum reached slowly equilibrium in the inner core of the fast reactor zone according to the nuclear fuel combination used. Critical experiments with a charge of 37 uranium fuel elements inside the fast reactor zone and with seven uranium plates for each fuel element in the thermal zone obtained maximal high intensity neutron pulses for the fast zero power assembly. Transl. by G.G.

N68-19029*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PROJECTED LARGE SCALE USE OF RADIOISOTOPES BY NASA
Robert E. English Washington 1966 12 p Presented at Am. Nucl. Soc. Meeting on Large Scale Production and Appl. of Radioisotopes, Augusta, Ga., 23 Mar. 1966
(NASA-TM-X-52187) CFSTI: HC$3.00/MF$0.65 CSCL 18B

For investigation of the problems connected with the design of large, isotope heat sources, the particular thermal power of 50 kW was selected. In general, the analysis is relevant for thermal powers ranging from 10–100 kW. The selected time period is the 1970's. The potential demand for isotopes during this period is estimated, and various candidate isotopes are compared on the basis of hazard and required weight. Author

N68-19042# Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik.
CALCULATION OF LARGE FAST REACTORS
D. Braess, R. Froelich, A. Jansen, A. Kuesters, and K. E. Schroeter Aug. 1967 28 p refs
(KFK-620; EURFNR-416; EUR-3689)

The fundamental procedure used in Karlsruhe for fast reactor calculations is presented. The preparation of multigroup constants, the determination of reactivity coefficients with the calculation of second criticality, and the long-term behavior of fast reactors are discussed in detail. NSA

N68-19044# Laboratoires du Centre d'Etude de l'Energie Nucleaire, Mol (Belgium).
USE OF PLUTONIUM AS FUEL IN NUCLEAR REACTORS
Jul. 1967 79 p refs Prepared jointly with Soc. Belg. pour l'Ind. Nucl.
(EURAEC-1929; EUR-3755; QR-14) CFSTI: HC$3.00/MF$0.65

A last series of fuel rods for neutronic tests of the 3% ^{235}U–1% plutonium type was produced. Preparation was started on the group of fuel rods containing 2% ^{235}U and 2.7% plutonium for the same nuclear physics program. A systematic study was made of different types of fixing grippers for rods to be filled by pneumatic vibration. Ceramographic examination of the fuel rods irradiated during the 4th irradiation run in the BR2 hydraulic conveyor is continuing. A method of obtaining "α" autogrammagraphs was perfected on the rods in this run. The 3rd boiling water capsule was unloaded after an effective irradiation of 115 days. According to the results at present available, the average power generated in the top part of the heterogeneous test piece would be 300 W/cm. When the appliance was dismantled, considerable cracking was found on the tube-can of the cross. PANTHER code options were applied to UO_2 and UO_2–PuO_2 lattices with different plutonium enrichments and isotopic compositions and to the calculation of the boron lattices. Author (NSA)

N68-19051# Idaho Nuclear Corp., Idaho Falls.
INCITE: A FORTRAN-4 PROGRAM TO GENERATE THERMAL NEUTRON SPECTRA AND MULTIGROUP CONSTANTS USING ARBITRARY SCATTERING KERNELS
R. L. Curtis and R. A. Grimesey Nov. 1967 85 p refs
(Contract AT(10-1)-1230)
(IN-1082) CFSTI: HC$3.00/MF$0.65

The computer program INCITE, which was written to calculate energy-dependent thermal neutron spectra and appropriate average multigroup cross sections using arbitrary scattering kernels, is described. The program employs a normalized Gauss–Seidel iteration technique to solve the energy-dependent integral form of the B-1 approximation to the Boltzmann transport equation. A maximum of 101 discrete energy points is utilized to represent the energy range. A library tape containing the proper absorption and scattering cross sections at these energy points is required. The current master library contains cross sections for 101 energy points in the energy range from 0.0 to 2.38 eV. The INCITE code is

written in FORTRAN-IV language and is presently operating on the IBM-7040 and the UNIVAC-1108 digital computers. The running time for INCITE depends on the number of isotopes in the problem as well as the size of the data records that must be processed for each isotope. However, the running time for a typical problem, such as the sample problem contained in the report, should rarely exceed seven minutes on the IBM-7040 or one minute of the UNIVAC-1108. Author (NSA)

N68-19066# Argonne National Lab., Ill. Reactor Physics Div.
ANALYSIS OF THE INITIAL CRITICAL EXPERIMENTS OF THE EBWR PLUTONIUM RECYCLE PROGRAM
P. H. Kier Aug. 1967 41 p refs
(Contract W-31-109-ENG-38)
(ANL-7368) CFSTI: HC $3.00/MF $0.65

The experimental results and the analysis for measurements of two Pu-fuel critical configurations, temperature coefficients of reactivity, H_3BO_3 worths and control-rod bank worths are presented. The temperature coefficients and H_3BO_3 worths were measured for the 36-Pu assembly loading and for the full fuel loadings. These critical experiments led to a revised computational model, which is also described. Author (NSA)

N68-19076# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
TEST SIMULATION OF THE TEMPERATURES OF THE DEERFIELD RIVER
R. T. Jaske Dec. 1967 41 p refs
(Contract AT(45-1)-1830)
(BNWL-628) CFSTI: HC $3.00/MF $0.65

A study was made to determine whether a mathematical system could simulate the temperature fluctuations in the Deerfield River from a point 5 miles below the Yankee Power Reactor to a downstream location near the confluence with the Connecticut River. Data required for the operation of the temperature model included water temperature records from 1958, river flow measurements, meteorological measurements, river dimensions, and advective heat quantities from the reactor installation. Tests performed for each simulation run indicated a minimum 68% accuracy of correlation with measured data. The program successfully demonstrated the capability of the simulation system in a wide range of environmental situations with routinely available field data. NSA

N68-19083# Babcock and Wilcox Co., Lynchburg, Va. Atomic Energy Div.
1000-MWe LMFBR FOLLOW-ON STUDY Quarterly Progress Report, 1 Jun.–31 Aug. 1967
D. Mars, comp. Oct. 1967 184 p refs Prepared for Argonne Natl. Lab., Ill.
(BAW-1312) CFSTI: HC $3.00/MF $0.65

The following are covered: (a) *Reactors, Fast*—description of 1000 MW(e) liquid metal-cooled breeder, reference design plant; fuel reloading operation for 1000 MW(e) liquid metal-cooled breeder, description of; (b) *Reactors, Liquid Metal-Cooled*—description of 1000 MW(e) fast breeder, reference design plant; coolant loss in 1000 MW(e) LMFBR, effects of sodium fires in; fuel reloading operation for 1000 MW(e) fast breeder, description of; (c) *Reactors, Breeder*—description of 1000 MW(e) liquid metal-cooled fast, reference design plant; fuel reloading operation for 1000 MW(e) liquid metal-cooled fast, description of; (d) *Reactor Fuel Elements*—design configurations of assembly for 1000 MW(e) LMFBR; (e) *Reactor Fuels*—economics of 1000 MW(e) LMFBR, effects of sodium void coefficient on; burnup of 1000 MW(e) LMFBR, effects of central void on; (f) *Uranium Oxides UO_2, Plutonium Oxides PuO_2–PuO_2–UO_2, thermal conductivity for 1000 MW(e) LMFBR fuel of, at 0 to 5000°F*; (g) *Pumps (Liquid Metal)*—description of 1000 MW(e) LMFBR; (h) *Heat Exchangers (Liquid–Liquid)*—sodium flow 1000 MW(e) LMFBR, description of; (i) *Heat Transfer Systems*—primary system flow temperatures for 1000 MW(e) LMFBR; (j) *Radioactive Waste*—disposal system for 1000 MW(e) LMFBR, description of gas and liquid; (k) *Sodium*—cooling system of, effects on reactor safety of fires in; and (l) *Reactors, Power*—fuel reloading of 1000 MW(e) liquid metal-cooled fast breeder, description of. NSA

N68-19131* Arizona Univ., Tucson. Nuclear Engineering Dept.
THE EFFECT OF ENVIRONMENT ON CERAMIC INSULATOR FOR NUCLEAR THERMIONIC APPLICATIONS
Monte V. Davis [1966] 35 p refs Presented at Joint Meeting of Am. Ceram. Soc. and Am. Nucl. Soc., Washington, 7–12 May 1966
(Grant NGR-03-002-056)
(NASA-CR-71913) CFSTI: $3.00 CSCL 18J

The effects of high temperature and high radiation fields on the physical properties of ceramic insulators have been investigated in radiation fields to approximately 5×10^6R per hour and at temperatures to approximately 2000° Kelvin. The thermal conductivity obeys the theoretical abeolete temperature relationship, and no measurable effect resulting from the radiation fields in the reactor to 5×10^6 R/hour was observed. The density of electrons is so low that they cause no measurable effect on the thermal conductivity where the transport of energy is by lattice waves. An analysis of the change in electrical conductivity with the impressed radiation field assuming a shift in the Fermi level within the material leads to agreement with the experiment. Based on the dynamic measurements of the physical properties of the insulators, beryllia and Lucalox appear to be the best insulators for in-core thermionic reactor systems. Author

N68-19146*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
NUCLEAR THERMIONIC SPACE POWER SYSTEM CONCEPT EMPLOYING HEAT PIPES
Colin A. Heath and Edward Lantz Washington Mar. 1968 24 p refs
(NASA-TN-D-4299) CFSTI: HC $3.00/MF $0.65 CSCL 18N

A space power system employing out-of-pile thermionic diodes and using concentric heat pipes for both heating and cooling of these diodes has been examined. For an early application, the out-of-pile thermionic diode has some advantages over an in-pile system because it is removed from the reactor environment. Moreover, the heat pipe permits emitter temperatures that are not much less than the temperature of the fuel clad. Laboratory data on the performance of heat pipes has been examined and the results used to estimate reasonable performance levels for thermionic diodes which were consequently incorporated into a small, fast-spectrum nuclear reactor concept. Performance levels and system weights including shield weights, have been estimated from first order calculations. The overall system can have the advantage of the safety inherent in heat pipe redundancy and the improved performance available from components that are removed from the reactor environment. Author

N68-19252# Kernforschungszentrum, Karlsruhe (West Germany). Inst. fuer Reaktorbauelemente.
THE SAFETY OF STEAM-COOLED FAST REACTORS AS INFLUENCED BY THE DESIGN AND ARRANGEMENT OF THEIR COMPONENTS
F. Erbacher, W. Frisch, W. Huebschmann, L. Ritz, and G. Woite Oct. 1967 53 p refs Prepared in cooperation with EURATOM
(KFK-655; EUR-3688.E) CFSTI: HC $3.00/MF $0.65

Discussed are reasons why the dynamic behaviour and the safety of a steam cooled fast reactor is particularly dependent on the design and the arrangement of the cooling cycle and its components. It is shown that by using a suitable design and arrangement a selfcontrolled system can be obtained and the

consequences of certain major accidents greatly reduced. Independent of any specific reactor design the criteria to achieve this are defined. Author

N68-19264# Oak Ridge National Lab., Tenn.
INITIAL DEVELOPMENT OF HFIR FUEL ASSEMBLIES
R. J. Beaver, J. W. Tackett, J. H. Erwin, G. M. Slaughter, and W. J. Kucera Oct. 1967 66 p refs
(Contract W-7405-ENG-26)
(ORNL-4108) CFSTI: HC$3.00/MF$0.65

Development of HFIR-type fuel assemblies aimed at demonstrating feasibility and concluded with the fabrication of the 8-kg-^{235}U aluminum-base fuel assembly for the HFIR Critical Experiment No. 2 is described. The fuel loading for this critical test was low enough that the alloy Al–24% U could be used as the fuel material for the outer-annulus plates. Boron was specified as a burnable poison addition to the inner-annulus plates only. Powder metallurgy was selected as the process for making a fuel mixture containing 25 wt % U_3O_8, 0.07 wt % B_4C, balance aluminum. These cores were first cold pressed to rectangular blocks and later hot pressed to the specified contour. Aluminum pieces were made to match the contours of both types of fuel cores. Alclad plates containing these contoured core pieces were made by hot rolling, and the plates were shaped into involutes. The plates were assembled into fuel arrays and joined by mechanical fastening and welding. The results of this program showed that processing HFIR fuel plates and elements with precise control of dimensions and fuel loading is feasible. Blistering of fuel plates was the major problem encountered. NSA

N68-19269# Sandia Corp., Albuquerque, N. Mex.
SNAP-27 CAPSULE BURIAL TESTS
F. L. Baker Aug. 1967 71 p
(SC-DR-67-716) CFSTI: HC$3.00/MF$0.65

Data generated by three soil burial tests of full-scale, electrically heated, simulated SNAP-27 fuel capsules are presented. These tests were performed by Sandia Laboratory as part of the SNAP-27 Safety Test Program. The capsules were buried in bentonite, Ottawa Sand and a mixture of bentonite, Ottawa sand, and feldspar. Author (NSA)

N68-19276# Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
FAST BREEDER REACTORS WITH DIRECT BOILING COOLANTS [PREDKIE REAKTORY POWIELAJACE BEZPOSREDNIO CHLODZONE WRZACHYM CHLODZIWEM]
M. Tayoe 1967 76 p refs In RUSSIAN; ENGLISH summary
(INR-842/C) CFSTI: HC$3.00/MF$0.65

A classification system is discussed for fast neutron atomic reactors. Concepts for fast breeders, fueled with fused chlorides of U, Pu, and Na(K), and cooled directly with boiling coolants, are discussed. The SAWA reactor, using $AlCl_3$ as a coolant, maintains the coolant and the fuel in a homogeneous state; while the WARS reactor, cooled with boiling Hg_{met}, maintains the fuel and coolant in a heterogeneous state. Preliminary calculations are given for power reactors of 1000 MWt each. Safety factors and specific bubble effects are discussed. Summary data are given for fuel recycling. Transl. by E.J.S.

N68-19323# Argonne National Lab., Ill.
REACTOR AND FUEL-PROCESSING TECHNOLOGY, VOLUME 10, NUMBER 4 Quarterly Technical Progress Review, Fall 1967
1967 72 p refs Prepared for AEC
CFSTI: HC$3.00/MF$0.65

The evolution of hot-channel factors over a period of about 10 years is illustrated for one particular operating power reactor, and measured and average values of basic fission parameters are reviewed. Proposed criteria for pressure vessels are presented. Summary data are provided on the kinetics of acid dissolution of uranium and thorium, methods for preparing graphite-matrix pyrolytic carbon (PyC)-coated particle fuels, and operations for recovering enriched uranium and plutonium from Pu–Al targets. Volatility processes are discussed in relation to the fluorination of oxide fuels with ClF_3 and ClF, fluid-bed fluorination of UO_2–PuO_2 fuel with bromine pentafluoride, and the preparation and properties of fluorides. Also discussed are pyrochemical processes which are being developed for ceramic (oxide or carbide), metallic, and molten-salt fuels. Demonstration pot calcination runs carried out with highly radioactive liquid wastes are discussed. Reference bibliographies are included. M.G.J.

N68-19431# Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik.
THE GERMAN FAST BREEDER PROGRAM
W. Haefele Oct. 1967 16 p refs Presented at the Symp. on Fast Reactor Phys. and Related Safety Probl., Karlsruhe, Ger., 30 Oct.–3 Nov. 1967
(KFK-634; SM-101/5; EUR-3678.E)

Consideration is given to the German fast breeder reactor program. The various reactor programs now in progress are briefly discussed in relation to the function and purpose of each. The three efforts leading up to development of fast reactor theory are examined and the various tasks in the field of reactor safety are assessed. B.S.D.

N68-19432# Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung.
SYSTEMS ANALYSIS OF A FAST STEAM COOLED REACTOR OF 1000 MW(E)
W. Frisch, F. Hofmann, E. Kiefhaber, H. Moers, K. Schramm et al Oct. 1967 25 p refs Presented at Intern. Atomic Energy Agency Symp. on Fast Reactor Phys. and Related Safety Probl., Karlsruhe, Ger., 30 Oct.–3 Nov. 1967
(KFK-636; SM-101/10; EUR-3680.E)

The results of a systems analysis on a steam cooled fast breeder reactor is reported. It comprises a systematic variation of various design parameters of the core and its influence on the power generating costs. The major objectives of the thermohydraulic, nuclear and cost investigations was to assess the possibility of making qualitative statements about the economical potential of a steam-cooled breeder reactor, and to establish quantitative design criteria for a prototype. The dependence of fuel inventory, breeding ratio, rating, core geometry and plant efficiency on coolant pressure, and coolant temperature was examined for two different rod powers. The effect of surface roughness at core outlet was investigated and compared to a case of a smooth surface with respect to possible improvement of heat transfer. The stability characteristics of the cores are studied and the dependence of the core stability on the varied parameters is shown. B.S.D.

N68-19480# Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorbauelemente.
PARAMETRIC STUDY OF THE DYNAMIC BEHAVIOR AND STABILITY OF A STEAM COOLED FAST REACTOR WITH AN INTEGRATED COOLANT CYCLE
F. Erbacher, W. Frisch, W. Huebschmann, S. Malang, L. Ritz et al Oct. 1967 50 p refs
(KFK-637; SM-101/18; EUR-3681.E)

The following report shows that in a steam-cooled fast breeder reactor it is possible in principle to produce inherent stability and safety from accidents by the feedback of the cooling cycle on the core. The effects of various parameters on stability and safety are determined for these disturbances: Reactivity disturbance, blower failure, load changes, various pipe ruptures, and inadvertent fast unflooding. This results in trends and limits that should be observed in the design of the components and the arrangement of the cooling cycle. It is shown that in particular a

cooling cycle integrated in a common pressure vessel produces easily inherent stability and safety of a steam-cooled fast reactor.
Author

N68-19490# DuPont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.
ANALYSIS OF FAILED 17-4 PH BOLTS FROM THE HWCTR
Robert P. Marshall Sep. 1967 20 p refs
(Contract AT(07-2)-1)
(DP-1102) CFSTI: HC $3.00/MF $0.65

Analysis of five bolts of 17-4 PH stainless steel from the Heavy Water Components Test Reactor that had failed in service showed that the failures were initiated by stress corrosion. In all but one of the failed bolts, an unstable crack size was reached after very little stress corrosion causing fast crack propagation and complete failure. In one bolt, the stress corrosion crack had stopped growing. Many of the bolts, including all those that failed, were found to have been improperly heat treated to approximately the H925 condition, instead of the specified H1100 condition. The harder H925 condition is conducive to stress corrosion cracking in this alloy. No evidence for failure by fatigue was found.
Author (NSA)

23 PHYSICS, GENERAL

Includes acoustics, cryogenics, mechanics, and optics. For astrophysics see: 30 Space Sciences. For geophysics and related information see also: 13 Geophysics; 20 Meteorology; and 29 Space Radiation.

N68-18282# California Inst. of Tech., Pasadena. Antenna Lab.
ELECTROMAGNETIC SCATTERING FROM CYLINDRICALLY AND SPHERICALLY STRATIFIED BODIES
Raymond W. Latham Nov. 1967 97 p refs
(Grant AF-AFOSR-68-1400)
(TR-42; AFOSR-67-2696; AD-664050) CFSTI: HC $3.00/MF $0.65

A method is developed for calculating the electromagnetic field scattered by certain types of bodies. The bodies consist of inhomogeneous media whose constitutive parameters vary only with the distance from some axis or point of symmetry. The method consists in an extension of the invariant imbedding method for treating wave problems. This method, which is familiar in the case of a one-dimensional inhomogeneity, is extended to handle special types of two and three-dimensional inhomogeneities. Comparisons are made with other methods which have been proposed for treating these kinds of problems. Examples of applications of the method are given, some of which are of interest in themselves.
Author (TAB)

N68-18324# Naval Research Lab., Washington, D. C.
A MATHEMATICAL MODEL OF A ROTATIONAL FREQUENCY TRANSLATION DEVICE Interim Report
D. Sachs 12 Dec. 1967 25 p refs
(NRL-6608; AD-664217)

An analysis was made which provides a theoretical explanation of a unique radiation torque experiment performed by Allen, in which circularly polarized (cp) microwave power was used to impart continuous rotary motion to an object supported within a circular waveguide. Under the action of the cp wave, an oscillating current was set up in a rod dipole resulting in an oscillating dipole moment. Part of the energy scattered by the rotating dipole is frequency shifted. Torques arise from the interactions between the E-field of the wave and the induced dipole moment, and between the oscillating current in the dipole and the longitudinal H-field in the waveguide. The magnitudes of these torques were derived for two cases of interest; the open waveguide and the shorted waveguide. The magnitudes of the spectral components of the radiation scattered by the dipole were also derived along with their characteristic polarizations. A cursory analysis shows that photons are conserved in such an experiment.
Author (TAB)

N68-18373# Royal Aircraft Establishment, Farnborough (England).
APPLICATION OF DYNAMIC PROGRAMMING TO THE BRACHISTOCHRONE PROBLEM
Dorothy M. Pullen Aug. 1967 21 p refs
(RAE-TR-67181; AD-664525)

The classical brachistochrone problem is formulated in dynamic programming terms and the resulting functional equation solved. The equation is first solved over a rectangular mesh and various methods of increasing the accuracy of the result and reducing the computer storage space required are considered. A good approximation to the true solution is obtained even though the numerical values chosen involve a singularity.
Author (TAB)

N68-18414# Massachusetts Inst. of Tech., Cambridge. Microwave and Quantum Magnetics Group.
SMALL SIGNAL POWER AND MOMENTUM THEOREMS FOR A MAGNETOELASTIC FERROMAGNET
Frederic R. Morgenthaler May 1967 29 p refs
(Contract AF 19(628)-5876)
(AFCRL-67-0664; SR-9; AD-664332)

Small signal equations of motion governing the magnetization and elastic displacement vectors in a magnetoelastic ferromagnet are used to find the time dependent and complex small signal power theorems, the small signal momentum conservation theorem, and the boundary conditions applicable at a passive surface of discontinuity. The theorems are also used to derive the approximate equations of motion governing localized wave packets described in terms of quasi-particles.
Author (TAB)

N68-18416# Rome Air Development Center, Griffiss AFB, N. Y.
A SUMMARY OF TERMINOLOGY AND CRITERIA EMPLOYED IN IMAGE QUALITY ASSESSMENT AND SPECIFICATION Technical Report, Sep. 1966–Mar. 1967
Robert H. LaSalle Dec. 1967 37 p refs
(RADC-TR-67-578; AD-664330) CFSTI: HC $3.00/MF $0.65

The report is the result of an in-house study of terms and performance criteria employed in the general field of image quality assessment. The underlying purpose of the effort is to provide information of value to those involved in various aspects of design, development, and use of electro-optical displays for military systems. A broad range of definitions is covered, with the intent of promoting a common understanding of the significance and usefulness of various image evaluation terminology which is in common use today. Some useful formulae as well as typically-acceptable values for selected performance factors are also presented.
Author (TAB)

N68-18438# Naval Research Lab., Washington, D. C.
TORQUE ON A SUPERCONDUCTING TOROID IN A UNIFORM FIELD Final Report
B. J. Wilson, E. E. King, and J. R. Miller 5 Dec. 1967 31 p refs
(NRL-6618; AD-664207)

The torques on superconducting lead toroids immersed in various uniform fields were measured and calculated as a function of angular position. The calculations, based on ideal superconducting behavior, agree with experiment for the closed torus, if persistent current decrease due to critical surface fields is considered. The recognition of trapped-flux phenomena is needed to explain the measured results for the open torus, when it has been cooled in a nonzero field or when a magnetic transition to superconductivity has been made. The analytical model used magnetic moments for

a torus in an axial field and in a perpendicular field, rigorously calculated elsewhere. These methods of obtaining approximations to the moments presented may possibly apply to more general toroidal bodies. The total magnetic moment (and thus the torque) for arbitrary angular position is found by superposition, a result not previously obtained. Author (TAB)

N68-18446# Aerospace Corp., El Segundo, Calif. Lab. Operations.
PREDICTIONS FOR FUTURE OF CRYOGENIC APPLICATIONS, JUNE 1966–FEBRUARY 1967
Robert W. Vance Oct. 1967 19 p refs
(Contract F04695-67-C-0158)
(TR-0158(3710-01)-1; SAMSO-TR-68-21; AD-664560)

A brief review of the state of the art in the production of cryogenic working fluids prefaces the forecasts for principal cryogenic applications. Applications discussed include food preservation and shipment, cryomedicine, superconductive devices, small coolers, and powerplants for future aircraft and space vehicle systems. Author (TAB)

N68-18457*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SHOCK-SPECTRUM ANALYSIS PROGRAM
D. C. Snyder and D. B. Wiksten 1 Mar. 1967 29 p ref
(Contract NAS7-100)
(NASA-CR-93435; JPL-TM-33-326) CFSTI: HC $3.00/MF $0.65 CSCL 20A

The shock spectrum analysis program for the 7094 computer computes the primary and residual shock spectra of a digital signal by the recursive filtering method. The program also automatically plots selected output on the SC-4020 plotter and punches the data on cards for additional analysis. The program is written in FORTRAN IV and MAP language. Author

N68-18474# Navy Underwater Sound Lab., New London, Conn.
PREDICTING THE MAGNETIC FIELDS FROM A TWISTED PAIR CABLE
J. Ronald Moser and Ralph F. Spencer (Texas Instr., Inc.) 12 Dec. 1967 27 p refs
(USL-848; AD-664241) CFSTI: HC $3.00/MF $0.65

A theory that predicts the magnitude of low-frequency magnetic fields near a current-carrying twisted-pair cable is developed. By asymptotically expressing the theoretical results, it is shown that the magnetic fields from a twisted-pair cable of pitch distance p decrease exponentially with the radial distance from the center of the cable. The asymptotically expressed result is verified experimentally for a radial distance as large as (3/2) p. At such a distance, the maximum fields from the cable are shown to be 50 db below that from a two-wire line (two parallel wires), even though both the cable and the wire line are carrying the same amount of current. Author (TAB)

N68-18479 California Inst. of Tech., Pasadena.
DIFFRACTION OF TRANSIENT ELASTIC WAVES BY A SPHERICAL CAVITY
Frederick Reyes Norwood (Ph.D. Thesis) 1967 140 p
Available from Univ. Microfilms: HC $6.60/MF $3.00 Order No. 67-4778

The diffraction of transient elastic waves by a spherical cavity is treated. Two cases are considered: (a) a suddenly applied normal point load, and (b) the impingement of a plane transient pulse on the cavity. The method used determines the solution only in the shadow zones; that is, those points which cannot be connected to the source of disturbance by straightline rays. Analytical results are obtained and evaluated for the displacements at the cavity wall. The analysis is based on the Laplace transform (on time) and the Watson transformation. This well-known transformation makes it possible to convert an infinite series involving a discrete real wave number into one involving a generalized wave number. This leads to transient solutions the components of which have a one-to-one correspondence with the modes of the underlying frequency equation. These solutions have a form convenient for numerical analysis and for obtaining approximate solutions. Dissert. Abstr.

N68-18481# Atomics International, Canoga Park, Calif.
MEASUREMENTS OF THE RESONANCE INTEGRAL AND DOPPLER EFFECT IN ^{186}W
L. S. Beller, D. W. Latham, and J. M. Otter 16 Oct. 1967 48 p refs
(Contract AT(04-3)-701)
(NAA-SR-12500) CFSTI: HC $3.00/MF $0.65

Measurements of the resonance integral at infinite dilution, the effective resonance integral for finite sample sizes covering a range of a decade and a half in surface-mass ratio (S/M), and the Doppler effect as a function of S/M and temperature in the isotope ^{186}W are presented. The integral values were obtained by comparing the measured cadmium ratio to that of gold. The measurements yielded a value of 450±36 barns above an assumed cadmium cutoff of 0.7810 eV for the resonance integral at infinite dilution. This is in good agreement with previous cadmium covered measurements. The effective resonance integrals for finite sample sizes appear to be somewhat lower than those obtained by others who used enriched ^{186}W. The Doppler effect measurements yielded values that are in strong disagreement with calculations using any of the presently proposed parameters for the first resonance in ^{186}W. The observed temperature dependence of the Doppler effect is also strongly different from that calculated for this isotope and from those calculated and observed for analogous conditions in other isotopes. Author (NSA)

N68-18546# Mitre Corp., Bedford, Mass.
EDDY CURRENT TORQUES AND MOTION DECAY ON ROTATING SHELLS
Joseph F. A. Ormsby Nov. 1967 62 p refs
(Contract AF 19(628)-5165; ARPA Order 596; Proj. Defender)
(MTR-224; ESD-TR-67-94; AD-664338)

The report describes a study conducted to estimate the torques acting on electrically conducting shells rotating in a magnetic field. The basic electromagnetic expressions leading to an evaluation of torque are given using various approaches with comparisons for the spherical shell. Application of these techniques to cylindrical shells with flat and hemisphere shell ends is described. The torques both slow and alter the direction of the rotating motion, and the resultant decay time constants can be in the order of days. Factors affecting this decay time and influencing shell design are examined. Author (TAB)

N68-18566# Rome Univ. (Italy).
PROPAGATION OF WAVES IN SPECIAL MEDIA AND GEOMETRIES Final Scientific Report, 1 Jun. 1964–30 Sep. 1967
Giorgio Barzilai and Giorgio Gerosa 6 Nov. 1967 43 p refs
(Contract AF 61(052)-807)
(AFCRL-68-0023; AD-664576)

A modal solution for a cylindrical waveguide of arbitrary cross section filled with longitudinally magnetized ferrite given by Ll. G. Chambers is criticized. The so-called thermodynamic paradox associated with a ferrite loaded rectangular waveguide is discussed. It is shown that various structures introduced by some authors to resolve the paradox are, even in the limit case, different structures from the original one leading to the paradox and therefore they do not help in the resolution of the apparent inconsistency. Some experiments have been carried out in order to explain how in a physical structure the power is actually dissipated. The theoretical behaviour of some microwave ferrite structures has been experimentally verified by detecting the thermal rise produced by the dissipated r.f. power at certain characteristic regions. The solution

found by other authors for the discontinuity problem between an empty rectangular waveguide and the same guide completely filled with transversely magnetized ferrite, solution which fails for a certain range of the ferrite parameters, has been modified by introducing a ferrite-metal surface wave, in order to obtain the correct solution. The problem of a plane uniform electromagnetic wave travelling in a vacuum region and obliquely impinging on a piezoelectric slab bounded on the opposite side by an elastic medium, either directly in contact with the piezoelectric medium or separated by it through a thin metallic sheet, has been considered. The power carried by the elastic wave transmitted in this last elastic medium has been computed for various values of the geometrical parameters and the maxima determined. Author (TAB)

N68-18571# Akademiya Nauk URSR, Kiev. Institut Theoreticheskoi Fiziki.
STATISTICAL MECHANICS OF IRREVERSIBLE PROCESSES
A. V. Shelest 1966 21 p refs
(ITF-66-7)

A kinetic equation for the density matrix of a small system was derived, based on an irreversible process in a system consisting of a subsystem and thermostat and assuming weak interactions between the two. The method did not use the hypothesis of phase disorder of the wave functions belonging to various eigenvalues of the Hamiltonian system. Author (NSA)

N68-18579# Joint Publications Research Service, Washington, D. C.
APPLICATION OF THEORETICAL GAME METHODS TO EVALUATION OF THE VIABILITY OF COMPLEX SYSTEMS
B. S. Fleyshman and J. F. Krapivin *In its* Tech. Cybernetics 5 Mar. 1968 p 17–34 refs (See N68-18577 09-19)

Problems of optimization of structure and behaviour of complex systems in conflicting situations are investigated in this work. The case is considered where two systems having vital important defensive and offensive elements are in conflict. The methods of game theory are used to find the optimal (in the sense of survival) behavior and structure of both conflicting systems. Author

N68-18600# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
POINCARE AND LORENTZ INVARIANT EXPANSIONS OF RELATIVISTIC AMPLITUDES
M. B. Sheftel, Ya. A. Smorodinskii, and P. Winternitz 1967 29 p refs Submitted for publication
(JINR-E2-3553)

A discussion of double expansions of relativistic amplitudes in terms of the irreducible representations of the homogeneous Lorentz group, suggested previously for arbitrary values of the kinematical variables s and t is given. The relation between these expansions and relativistic phase shift analysis in terms of various little groups of the Poincaré group is studied. Author (NSA)

N68-18668# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
NEWS OF INSTITUTIONS OF HIGHER LEARNING. AERONAUTICAL ENGINEERING
10 Apr. 1967 215 p refs Transl. into ENGLISH of Izv. Vyssh. Ucheb. Zaved., Aviats. Tekh. (Kazan), no. 1, 1965 p 1–159
(FTD-MT-65-72; AD-663935) CFSTI: HC $3.00/MF $0.65

In the articles and technical notes presented, the subject matter pertains to aerodynamics, structural mechanics, thermodynamics, fluid mechanics, and propulsion systems. For individual titles, see N68-18669 through N68-18690.

N68-18689# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CONCERNING SYSTEMS THAT INTERACT WITH A FINITE VELOCITY OF SIGNAL PROPAGATION [O SISTEMAKH, VZAIMODEYSTVUYUSHCHIKH S KONECHNOI SKOROST'YU RASPROSTRANENIYA SIGNALOV]
G. I. Kostychev *In its* News of Inst. of Higher Learning. Aeron. Eng. 10 Apr. 1967 p 1–5 refs (See N68-18668 09-23)

Within the confines of classical variational calculus, the necessary extremum conditions are obtained for the problem of optimum interaction of two objects with an infinite velocity of signal propagation. The vector functions for such a system are determined, and a system of equations is obtained. While these are similar to classical equations, analytic solutions to them are much more difficult and analytic solutions were obtained only for several very simple examples of an academic nature. E.J.S.

N68-18712# Dartmouth Coll., Hanover, N. H. Dept. of Physics.
PVT RELATIONS IN SOLID HE-3 AND SOLID HE-4: FLOW MEASUREMENTS WITH SUPERFLUID HELIUM Final Technical Report
John N. Kidder [1967] 11 p refs
(Contract AF 49(638)-1518)
(AFOSR-68-0150; AD-664089)

Studies were made of the flow of liquid helium in round capillaries and orifices with diameters between 70 and 300 microns. Gravitational flow is caused by a mechanical displacement of the liquid from an equilibrium level. This technique was used in a series of experiments on the flow of helium at 0.4K in an attempt to discover the macroscopic flow properties of pure superfluid in moderate sized channels. The experimental conditions were chosen as a reasonable approximation to isothermal flow of pure superfluid. Results are in agreement with previous experiments with liquid helium, namely that below a certain critical velocity the superfluid flows with no dissipation, that is with zero pressure gradient. Author (TAB)

N68-18850# Boeing Scientific Research Labs., Seattle, Wash. Flight Sciences Lab.
TRANSFER OF TURBULENT ENERGY AND SCALAR QUANTITIES AT LARGE WAVE NUMBERS
Yih-ho Pao Oct. 1967 11 p refs
(TM-54)

The continuous spectral cascading concept for turbulent energy and scalar quantities is reformulated. It is shown that the spectra obtained from this concept are identically the same as those obtained with the postulation that the universal functions of the spectra and the spectral flux are similar. M.G.J.

N68-18901# Argonne National Lab., Ill.
STATISTICAL THEORY OF ELECTRIC POLARIZATION
A. Bellemans (Brussels Univ.) Aug. 1967 48 p refs
(Contract W-31-109-ENG-38)
(ANL-7381) CFSTI: HC $3.00/MF $0.65

The statistical theory of dielectrics is reviewed, insofar as linear effects in the field are concerned. The static dielectric constant is described in terms of the electric polarization of matter, the dielectric constant, the relations between $\underline{E}$ and $\underline{E}_0$ in special cases, the classical problems of electrostatics, the Onsager theory, the assembly of dipolar molecules in an external field, a general statistical formulation of ϵ, nonpolar and polar substances, high temperature expansions, and the Debye equation. The dynamic dielectric function is examined in relation to the behavior of a dielectric body in a time-dependent field, the dynamic dielectric function, relations between $\underline{E}$ and $\underline{E}_0$ in special cases, macroscopic and general formulations of $\epsilon(\omega)$, Brownian motion and dielectric relaxation, the description of a system in phase space, the response of a system to an electric field, generalized static theory of Kirkwood (polar substances), the correlation function $\psi(s)$, some results of molecular dynamics, and perturbation methods of statistical mechanics of irreversible processes. A reference bibliography is included. M.G.J.

N68-18940# Oak Ridge National Lab., Tenn.
GAS ABSORPTION THEORY APPLIED TO CONTAINMENT SPRAYS
L. F. Parsly, Jr. Jan. 1968 34 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-2002) CFSTI: HC $3.00/MF $0.65

A brief review is presented of the pertinent literature on the gas absorption theory as applied to containment sprays. It is demonstrated that equilibrium and mass-transfer rate equations may be used to predict spray performance for removal of fission product compounds from building atmospheres. A simplified procedure for calculating the effect of condensation on the spray performance is presented; this gives an overly conservative answer.
Author (NSA)

N68-18952*# National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, Fla.
NOISE: EFFECTS ON MAN AND MATERIALS. A SELECTED BIBLIOGRAPHY
15 Feb. 1968 32 p
(NASA-TM-X-60904; GP-464) CFSTI: HC $3.00/MF $0.65 CSCL 20A

An annotated bibliography on the effects of noise on men and materials is presented. For the purposes of this compilation, noise is defined as unwanted sound. Some references to the literature of electrical noise were considered germane and therefore included, however, the greater part of the material covered was limited to audioacoustic noise.
E.J.S.

N68-18980*# Tennessee Univ., Memphis. Herff School of Engineering.
DIMENSIONAL ANALYSIS HANDBOOK ARRANGEMENT RELATIONSHIPS FOR DIMENSIONAL ANALYSIS (ARDA)
H. F. Mullikin 1967 223 p Presented at the NASA-ASEE Summer Faculty Fellowship Program, 13 Jun.–19 Aug. 1966 Revised
(NASA-CR-616134) CFSTI: HC $3.00/MF $0.65 CSCL 20

Physical data obtained on various-sized equipment must be correlated in an orderly manner to establish general physical laws or equations governing the phenomena. Dimensional analysis presents a mathematical procedure for this correlation. Usual procedures have been modified in viewpoint and a so-called ARDA dimensional analysis method of mathematical attack is presented in encyclopedic format. The methods of application to such domains of physical knowledge as fluid drag, bubble mechanics and nucleation, convection heat transfer and tank pressurization.
Author

N68-19017# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy
ONE REMARK TO SPECIAL THEORY OF RELATIVITY [ZAMECHANIE K SPETSIAL'NOI TEORII OTNOSITEL'NOSTI]
V. N. Strel'tsov 1967 9 p refs In RUSSIAN
(JINR-P2-3482)

In the framework of the special theory of relativity a different way of describing events is proposed. In this way the events taking place near the observer are classificated by measuring length but not duration.
Author (NSA)

N68-19038*# Miami Univ., Fla. Center for Theoretical Studies.
THE PHOTOELECTRIC EFFECT WITHOUT PHOTONS
Willis E. Lamb, Jr. and Marlan O. Scully (MIT) Feb. 1968 15 p refs
(Grant NGR-10-007-010; Contract ARPA SD-90)
(NASA-CR-93557; CTS-QED-68-1) CFSTI: HC $3.00/MF $0.65 CSCL 20J

A mathematical model is formulated for a photodetector consisting of a collection of completely independent atoms. Each atom has one electron and is bathed in a classical electromagnetic field. On the basis of this model, it is shown that the photoelectric effect is the result of a classical field falling on a quantized atomic electron, and further, that the introduction of the photon concept is neither logically implied by, nor necessary for, explanation of the photoelectric effect.
E.J.S.

N68-19043# Hahn-Meitner-Institut fur Kernforschung, Berlin (West Germany).
ANNUAL REPORT, 1966 [JAHRESBERICHT 1966]
Apr. 1967 174 p refs In GERMAN
(HMI-B-50)

The annual report for 1966 of the Hahn–Meitner Institut is presented. Studies made in nuclear chemistry, mathematics, nuclear physics, radiochemistry, electronics, reactor physics, and radio-physics are briefly indicated. Abstracts are presented of completed studies. A publication list is given for each section.
NSA

N68-19117 Stanford Univ., Calif.
SMALL ANGLE X-RAY SCATTERING BY LIQUID He^3
Nareshchandra Premchand Shah (Ph.D. Thesis) 1967 91 p
Available from Univ. Microfilms: HC $4.80/MF $3.00 Order No. 67-7966

A study was made of the velocity of high frequency sound in He^3 by scattering X-rays from the liquid and studying the temperature dependence of the scattering cross section at small angles. This study was undertaken to verify the prediction of L. D. Landau that sound waves, different in character from that of normal (hydrodynamic) sound, can be propagated in liquid He^3 when the wavelength of the sound wave is small compared to the mean free path between collisions of particles. Such a sound mode in liquid He^3 was named zero sound mode by Landau. The theory predicts a higher value for zero sound mode. The theory predicts a higher value for zero sound velocity than for normal sound velocity. The theory of a Fermi liquid predicts that the mean free path or the collision time τ is inversely proportional to the square of the temperature. Thus, if one measures the velocity of a sound wave of a particular angular frequency ω as a function of temperature, one should observe a transition from normal sound velocity to zero sound velocity at a temperature where $\omega\tau$ is about one. In this thesis a brief theoretical discussion of the scattering of X rays at small angles is presented. An apparatus constructed for this purpose is described in detail.
Dissert. Abstr.

N68-19122 Stanford Univ., Calif.
THE STATISTICAL MECHANICS OF PHASE TRANSITIONS
James Douglas Gunton (Ph.D. Thesis) 1967 219 p
Available from Univ. Microfilms: HC $9.90/MF $3.00 Order No. 67-7919

In this work we develop a point of view in which a 'physical asymptotic analysis' of the critical point problem is attempted. This is, we try to focus only on those physical aspects characterizing the true cooperative nature of the critical point transition. To do this, we examine the precise relationship between an infinite system and the infinite number of finite, but macroscopically large subsystems of which it may be regarded as being composed. Two aspects of this relationship are considered, the first being concerned with the magnitude of fluctuation of the density of a finite region of an infinite system at its transition point. The second aspect which is considered is the relationship of the singular properties of an infinite system near its transition point to the interaction between its subsystems (cells). These interactions reduce, by virtue of the finite range of the forces between individual particles, to surface interactions between neighbor cells. This leads to a generalized near-neighbor lattice problem, which we call the interaction problem. A physically plausible form for the solution of this interaction problem is conjectured and its validity demonstrated for the cases of the d-dimensional Bose gas and the two-dimensional Ising model.
Dissert. Abstr.

N68-19191 Stanford Univ., Calif.
SCATTERING OF X-RAYS BY LAYERED STRUCTURES
William Randolph Jones (Ph.D. Thesis) 1967 129 p
Available from Univ. Microfilms: HC $6.20/MF $3.00 Order No. 67-7930

The diffraction of X-rays by perfect layered crystal structures is analyzed, with particular attention given to both the incidence of plane waves and collimated beams on a crystal plate of finite breadth set for Laue diffraction (or substantial transmission). The plane wave diffraction effects are obtained by a mode of analysis employing integral equations and the Wiener–Hopf method of solution; and it is shown that the analytical expressions for the transmission coefficients agree, as regards their leading terms, with the results of the two wave approximation for the diffraction theory of periodic structures derived by von Laue and others. The X-ray beam analysis, based on the principle of superposition of plane wave components, is developed to yield directly the spatial profiles of the transmitted beams and the phenomenon of beam separation; a significant outcome of the present approach is that the calculated profiles remain finite at the beam edges, in contrast with the singular behavior exhibited by previously given distributions. Dissert. Abstr.

N68-19219*# Harvard Coll. Observatory, Cambridge, Mass.
DIFFUSE REFLECTION AND TRANSMISSION BY CLOUD AND DUST LAYERS
William M. Irvine Feb. 1968 27 p refs Presented at Symp. on the Interdisciplinary Aspects of Radiative Energy Transfer, Philadelphia
(Grant NsG-89-60)
(NASA-CR-70496) CFSTI: HC $3.00/MF $0.65 CSCL 04A

The problem of radiative transfer in a medium with a strongly anisotropic phase function is considered. Traditional methods of solution of the transfer equation have not proved practicable. Recent calculations using the Neumann solution, Romanova's method, and the "doubling method" of van de Hulst are described. To facilitate the study of absorption features under conditions of multiple scattering, the probability distribution of photon optical paths is introduced. When appropriately normalized, this distribution satisfies a transfer equation. Author

N68-19221*# Chicago Univ., Ill. Dept. of Biophysics.
LOW TEMPERATURE ELECTRON MICROSCOPY WITH HIGH FIELD SUPERCONDUCTING LENSES
H. Fernandez-Moran [1965] 8 p refs Presented at 6th Intern. Cong. for Electron Microscopy, Kyoto, 27 Aug.–4 Sep. 1966
(Grant NsG-441)
(NASA-CR-76630) CFSTI: HC $3.00/MF $0.65 CSCL 20F

Two approaches to the design of cryo-electron microscopes are described. The first involves an optical bench system using high field superconducting niobium–zirconium solenoid lenses in liquid helium dewars. This system operates at 4 to 32 kG without pole pieces, or with modified objective, and objective-projector pole pieces. An additional current vernier control circuit for the superconducting objective solenoid is used in conjunction with a 25 A regulated power supply to permit adjustable current changes of 10^{-5} for achieving reproducible superfine focusing at orders of magnitude better than conventional systems. This device consists of a low field two-winding superconducting toroid with its secondary connected in series with the main solenoid. The other approach uses special superconducting objective lenses in liquid helium cryostats which may be used as integral parts of cryo-electron microscopes, or to replace the objective lenses in modified high resolution commercial electron microscopes. The superconducting objective lens is in a special dewar comprising a main Nb–Zr coil with vernier coil, superconducting stigmators, persistent current switches and improved current control devices. E.J.S.

N68-19278 Oklahoma Univ., Norman.
THE TRANSIENT RESPONSE OF A HELMHOLTZ RESONATOR WITH APPLICATION TO SONIC BOOM RESPONSE STUDIES
James Donald Simpson, Jr. (Ph.D. Thesis) 1966 147 p
Available from Univ. Microfilms: HC $7.00/MF $3.00 Order No. 67-7285

The response of a Helmholtz resonator to transient pressure pulses was investigated to ascertain under what conditions the simple oscillator analogy which is used for very low frequency steady state analysis is valid in the transient response problem, to determine the importance of higher mode responses to pulse inputs, and to investigate the need for restrictions or limitations in transient response analysis such as the low frequency limitation which must accompany the lumped parameter model in the steady state situation. The application to the sonic boom problem was investigated extensively. Both theoretical and experimental studies were made. The experimental work involved development of test apparatus capable of sonic boom simulation. Dissert. Abstr.

N68-19282 IIT Research Inst., Chicago, Ill.
ON THE STABILITY OF CONTINUOUS ROTORS
Ronald Lloyd Eshleman (Ph.D. Thesis) 1967 160 p
Available from Univ. Microfilms: HC $7.40/MF $3.00 Order No. 67-6968

The stability of continuous rotors subjected to axial torque was investigated analytically and experimentally. A set of general equations of motion that included gyroscopic moments, transverse shear and rotatory inertial effects was derived for rotor systems subjected to axial torque. The equations of motion and their associated boundary conditions for long and short bearings were cast in non-dimensional complex form. For constant axial torque, a classical eigenvalue problem was obtained. It was found that constant axial torque has a significant effect on the critical speeds of slender rotors whereas the effects of gyroscopic moments, transverse shear, and rotatory inertia are important when calculating the critical speeds of heavier rotors. An experimental apparatus was developed to study the effect of axial torque on the stability of continuous rotors. The apparatus is capable of inducing controlled axial constant, pulsating and combinations of constant and pulsating torques to high speed rotor systems. Dissert. Abstr.

N68-19332*# Stanford Univ., Calif. Remote Sensing Lab.
COMPUTER REDUCTION AND ANALYSIS OF AN INFRARED IMAGE
Keenan Lee 31 Dec. 1967 53 p refs
(Grant NGR-05-020-115)
(NASA-CR-93697; SU-RSL-TECH-67-4) CFSTI: HC $3.00/MF $0.65 CSCL 20F

Raw infrared scan imagery comprises three variables—two direction dimensions and film tone. Film tone, or density, may be reduced to absolute temperature by digitizing the data (manually or by machine) and submitting it to a computer. A Fortran IV program has been written for the IBM 7090 to accomplish this. Another program is included which fits a three-dimensional trend surface to the temperature data and computes thermal residuals. The trend surface maps define temperature patterns, and thermal residual maps isolate local anomalies. As an illustration, one infrared image is followed through the reduction and analysis procedure, from film to isothermal, trend and residual maps. The total cost for one complete run was $80. Author

N68-19364*# National Aeronautics and Space Administration, Washington, D. C.
THE PUMPING SPEED FOR CARBON DIOXIDE BY THE ACTION OF A SURFACE COOLED BY LIQUID NITROGEN AT GAS TEMPERATURES RANGING FROM 136°K TO 548°K [UNTERSUCHUNGEN DES SAUGVERMOEGENS EINER MIT FLUESSIGEM STICKSTOFF GEKUEHLTEN FLAECHE FUER KOHLENDIOXID BEI GASTEMPERATUREN VON 136°K BIS 548°K]
G. Saenger Mar. 1968 19 p refs Transl. into ENGLISH from German Rept. DVL-67-43, Jul. 1967
(NASA-TT-F-11547; DVL-67-43) CFSTI: HC $3.00/MF $0.65 CSCL 20M

A brief description is given on the measuring equipment concerning the pumping speed for carbon dioxide by the action of a surface cooled by liquid nitrogen at gas temperatures ranging from 136°K to 548°K, and the discussions of the measuring results for pressures ranging from 6×10^{-7} Torr up to 8×10^{-5} Torr. It also presents theoretical deliberations on the relation of the pumping speed of cryosurfaces with the thermal conductivity of the condensed gas layer. It is thus possible, after the constants have been determined, to predict the pumping speed of cryosurfaces in vacuum, within certain limits, also for other temperatures of the cryosurface and the condensing gas. Author

N68-19399*# National Aeronautics and Space Administration, Washington, D. C.
WEIGHTLESSNESS RESEARCH AT O.N.E.R.A. [LES RECHERCHES SUR L'ETAT D'IMPESANTEUR A L'O.N.E.R.A.]
H. Le Boiteux Mar. 1968 25 p refs Transl. into ENGLISH from Astronaut. Acta, v. 13, no. 3, 1967 p 289–303
(NASA-TT-F-11515) CFSTI: HC $3.00/MF $0.65 CSCL 20

The state of weightlessness peculiar to satellites and space probes has very important consequences for the crew and for the equipment in the vehicle. After this state is defined, and various possibilities for studying it are presented, details are given regarding its simplest form, free fall. Two facilities built at O.N.E.R.A., one for atmospheric free fall and the other for free fall in a high vacuum, are described and some examples of studies in progress are mentioned. It is now possible to reduce the gravity effect to 1×10^{-9} of its usual value for 3 seconds. Author

N68-19400*# Chicago Univ., Ill. Biophysics Dept.
APPLICATIONS OF IMPROVED POINT CATHODE SOURCES TO HIGH RESOLUTION ELECTRON MICROSCOPY
H. Fernandez-Moran [1966] 8 p refs Presented at the 6th Intern. Congr. for Electron. Microscop., Kyoto, 27 Aug.–4 Sep. 1966
(NASA-CR-76628) CFSTI: HC $3.00/MF $0.65 CSCL 20C

Improved point cathode sources have been developed and used routinely in high resolution microscopes. Pointed filaments are made of etched, oriented single-crystal tungsten tips spot-welded on zone-refined tungsten wire. Because of high purity and selected crystal orientation, these filaments have longer average life and operational stability than standard or sharpened hairpin cathodes. This also reduces specimen damage by energetic ions commonly originating from impurities in normal tungsten sources. Similar pointed filaments of high purity tantalum, rhenium and niobium have specific properties particularly useful for low-temperature microscopy. Best results were consistently obtained with new types of etched molybdenum or stainless steel caps, the key element of which is a replaceable disc aperture of thin (10–30μ) molybdenum foil with a precisely centered small hole of 0.5mm. The Mb foil is stable under electron bombardment which retards contamination and prolongs operational life of filament tips. Author

N68-19446 Technische Hochschule Stuttgart (West Germany). Arbeitsgemeinschaft fuer Raketentechnik und Raumfahrt.
INTERNATIONAL SYSTEM OF UNITS [DAS INTERNATIONALE SYSTEM DER EINHEITEN]
1967 38 p refs In GERMAN and ENGLISH

This compilation is based on the recommendations of the 11th General Conference on weights and Measures, held in 1960 at Paris, France. Presented are tables with the basic units of the international system of units and their definitions, multiples and submultiples of these units, supplementary and derived units, physical constants, and a conversion table for German and Anglo-American units of measurement. K.W.

24 PHYSICS, ATOMIC, MOLECULAR, AND NUCLEAR

Includes atomic, molecular, and nuclear physics. For applications see: 22 Nuclear Engineering. For related information see also: 29 Space Radiation.

N68-18270# Aerospace Corp., El Segundo, Calif. Lab. Operations.
BANDWIDTH DEPENDENCE OF MEASURED ULTRAVIOLET ABSORPTION CROSS SECTIONS OF ARGON, MARCH–JULY 1967
Robert D. Hudson and Virginia L. Carter Nov. 1967 29 p refs
(Contract F04695-67-C-0158)
(TR-0158(9260-01)-2; SAMSO-TR-68-34; AD-664561)

The atomic absorption cross section of neutral argon between the (2)P3/2 and (2)P1/2 states of the Ar(+) ion was measured at an instrumental bandwidth of 0.04A. Accurate line shapes for the (3s)(2) (3p)(5) (2)P1/2 nd transitions have been obtained for n = 9 to 20. Also presented are oscillator strengths and line positions for n = 9 to 30. In the course of this investigation, an analysis was made of the effect of instrumental bandwidth on measured absorption cross sections and line shapes in the ultraviolet. It is demonstrated that, contrary to the assumptions made by many ultraviolet spectroscopists, a linear Beers Law plot does not necessarily indicate that a true peak or minimum absorption cross section has been measured. Errors of as much as a factor of two can be introduced by this assumption. The results presented in this paper were corrected for this effect. Discrepancies between these and earlier measurements are shown to be consistent with the analysis. Author (TAB)

N68-18273# Miami Univ., Coral Gables, Fla. Center for Theoretical Studies.
A GENERAL STUDY OF THE WIGNER COEFFICIENTS OF SU(1,1)
Wayne J. Holman, III and Lawrence C. Biedenharn, Jr. (Duke Univ.) [1967] 35 p refs Prepared jointly with Duke Univ., Durham, N. C.
(Grant AF-AFOSR-1268-67)
(AD-664307)

The Wigner coefficients which couple any two irreducible unitary representations of the noncompact group SU(1,1) are derived by means of the second-order difference equation which defines them. It is found that whenever at least one of the three representations being coupled is discrete, then the two solutions are degenerate, but two linearly independent non-trivial solutions exist, in general, when all three representations are continuous. For this case two orthonormal solutions are found. Some elementary symmetries of the solutions are examined. The integral over the group manifold is regularized by means of a convergence factor in order to make all the irreducible unitary representation functions (the Bargmann functions) mutually orthonormal. This regularization is used for the investigation of the resolvent of the Laplace-Beltrami operator in the space of the Bargmann functions. Author (TAB)

N68-18280# Aerospace Corp., El Segundo, Calif. Materials Sciences Lab.

RELATIVE INTERACTION RADII FOR QUENCHING OF TRIPLET STATE MOLECULES

Seymour Siegel and Henry S. Judeikis Sep. 1967 31 p refs

(Contract F04695-67-C-0158)

(TR-0158(3250-20)-3; SAMSO-TR-67-115; AD-664091)

The relative efficiencies with which O2, NO, and Xe enhance the transition from the excited triplet state to the ground state in naphthalene have been determined from static experiments. Essentially the experiments consisted of the observation of the steady state phosphorescent emission intensity and the intensity of the electron spin resonance (ESR) signal of the triplet state molecules as functions of added quencher. All measurements were made in 3-methylpentane (3-MeP) glass solutions at 77K, where material diffusion is minimized. The derived results are discussed in terms of triplet state quenching by energy transfer to the quencher and by the enhancement of intramolecular triplet-singlet intersystem crossing. Since NO does not have the necessary energy levels for energy transfer from naphthalene to proceed, the result that the value for the effective interaction distance for the quenching process for NO is larger than that for O2 indicates that energy transfer probably does not occur in the O2 case either. TAB

N68-18302# Aerospace Research Labs., Wright-Patterson AFB, Ohio.

COMPUTER PROGRAMS FOR THE ANALYSIS OF GAMMA RAY ANGULAR CORRELATION MEASUREMENTS

A. K. Hyder, Jr. and D. D. Watson Aug. 1967 129 p refs

(ARL-67-0168; AD-664054) CFSTI: HC $3.00/MF $0.65

This report contains a description and listing of computer programs useful in the analysis of data on intensity-direction correlations of successive radiative transitions from aligned nuclei. A brief discussion of the methods used in extracting energy level spins, population parameters, and multipolarity mixing ratios from intensity-direction correlation measurements is given. The methods provide for simultaneous analysis of angular-distribution and triple-correlation measurements, and can be used for the analysis of double- and triple-correlation measurements where multi-step cascades involving intermediate unobserved transitions occur. The computer programs described are written in FORTRAN IV for use on an IBM 7094(II) computer. The complete program listings are included together with flow charts. Listings of sample input to and output from the programs are given. In addition, a description and listing is given of a program for the calculation of correction factors for finite geometry effects. Author (TAB)

N68-18352# Stanford Research Inst., Menlo Park, Calif.

RESEARCH ON METASTABLE SPECIES IN ATOMIC AND MOLECULAR BEAMS PRODUCED BY CHARGE TRANSFER, TASKS 1, 2, AND 3 Semiannual Report, Jan. 28–Sep. 30, 1967

M. Hollstein, D. C. Lorents, J. R. Peterson, and R. A. Young 27 Dec. 1967 82 p refs

(Contract DA-31-124-ARO(D)-446; ARPA Order 553; Proj. Defender)

(AROD-5134.5-P; SAR-2; AD-664169) CFSTI: HC $3.00/MF $0.65

Near-resonant electron capture reactions are being used to produce beams of long-lived excited atoms and molecules (metastables) suitable for studies of important collision processes of such species. The research has progressed sufficiently to allow the measurement of cross sections as a function of kinetic energy for metastable deactivation processes. Reactions in which the deactivation was dominated by Penning ionization or by symmetric energy transfer were chosen for study so that cross sections for these particular processes could be obtained. Studies of the optical radiation emitted from states excited by electron capture collisions have also provided useful results. Measurements of the gas phase quenching and reactions of O((1)D) by O2, N2O, CO, CO2, and H2 are nearing completion. The excitation and de-excitation of O2(b(1)Sigma+), N2(A(3)Sigma+u), and O((1)S) in a weak discharge are being successfully studied. TAB

N68-18443# Los Alamos Scientific Lab., N. Mex.

NEW MEASUREMENTS OF THE FLUORESCENCE EFFICIENCY OF AIR UNDER ELECTRON BOMBARDMENT

Paul L. Hartman 17 Jan. 1968 27 p refs

(Contract W-7405-ENG-36; ARPA Order 631)

(LA-3793; AD-664103)

The fluorescence efficiency of air under electron bombardment was measured at a pressure corresponding to an altitude of 65 km, for electron energies near 700 eV, with the principal measurements at the bright 3914-A band of the N2(+) ion. Efficiencies for the 3914-A band from two methods of observation were in good agreement, and gave a value eta-3914 = 0.34%. Spectra were obtained for air emission in the range 2500 to 12,000 A. Comparison of the radiation in the 3914-A band to that in the whole spectrum gave a total efficiency of 1.86% for this spectral range. Efficiencies of some individual bands of the N2 first and second positive systems were also determined by comparison with the 3914-A band. The 3914-A efficiency, for electron energies of 165 eV to 1 keV, was found to be nearly independent of energy, rising perhaps as the 0.07th power of the energy in this range. The dependence on pressure of the light output in the spectral range 3000 to 11,000 A was observed for electron energies of 750 and 1425 eV and pressures of 30 to 960 mu. The efficiency of the 3914-A band is independent of pressure below 100 mu. Above 100 mu, efficiencies of the N2(+) first negative and N2 first and second positive bands decrease with increasing pressure, the first positive decreasing most rapidly and the second positive least rapidly. Author (TAB)

N68-18452# Institute of Nuclear Research, Vienna (Austria).

ERGODIC THEORY AND DISCRETE TRANSPORT PROCESSES Final Technical Report, 1 Jul.–30 Sep. 1967

H. Hejtmanek Oct. 1967 35 p refs

(Contract DAJA37-67-C-0959)

(AD-664026)

Discrete transport processes occur in the computational treatment of neutron transport problems in reactor physics and shielding. The time dependance of the particle density function, especially the asymptotic behavior of it, has been studied. Mean ergodic theory is applied to prove uniqueness of equilibrium. Then mixing and ergodicity of the transport process is established. Author (TAB)

N68-18473# Sandia Corp., Albuquerque, N. Mex.

ABSOLUTE DETERMINATION OF 14-MEV NEUTRON YIELDS

T. R. Fewell Aug. 1967 35 p refs

(Contract AT(29-1)-789)

(SC-RR-67-346) CFSTI: HC $3.00/MF $0.65

The problem of determining the absolute yield of neutrons from the T(d,n)α reaction is examined. Techniques are developed for determining the number of neutrons produced in a TiT target per α particle emitted into any solid angle. The formulas developed can be used for various α detector locations and deuteron beam energies. The techniques are also extended to handle unanalyzed beam conditions. Geometry considerations and other problems are also discussed. The absolute accuracy of these techniques is established for the optimal target assembly of two α detectors located at 90 degrees and 135 degrees with respect to the accelerated deuteron beam. Author (NSA)

N68-18483# Gosudarstvennyi Komitet Po Ispolzovaniyu Atomnoi Energii, Moscow (USSR). Institut Teoreticheskoi i Eksperimental'noi Fiziki.

DETERMINATION OF NEUTRON DISTRIBUTION IN A CYLINDRICAL BLOCK BY A METHOD OF SUCCESSIVE COLLISIONS [OPREDELENIE RASPREDELENIYA NEITRONOV V TSILINDRICHESKOM BLOKE METODOM POSLEDOVATEL'NYKH STOLKNOVENII]

V. M. Mikhailov 1966 32 p refs In RUSSIAN; ENGLISH summary

(ITEF-482)

An approximate method based on the successive generation approach is given for the solution of problems related to neutron transport in a cylindrical rod. The distribution of neutrons of an n-th generation is determined by means of three of its characteristics: the values in the center of the rod, at its surface, and the mean density over the rod. Tables are presented which simplify the numerical calculations involved. Author (NSA)

N68-18493*# Aztec School of Languages, Inc., Acton, Mass.

PROPERTIES AND APPLICATIONS OF MOLECULAR FORCES [UBER EINEGE EIGENSCHAFTEN UND ANWENDUNGEN DER MOLEKULARKRAFTE]

F. London Washington NASA Mar. 1968 28 p refs Transl. into ENGLISH from Z. Physik. Chem. (Frankfurt), v. 11, 1930 p 222–251

(Contract NASw-1692)

(NASA-TT-F-11497) CFSTI: HC $3.00/MF $0.65 CSCL 20H

The attractive forces between molecules can be obtained simply in approximate form on the basis of a dispersion curve along, i.e., from purely optical data; these forces derived from the dispersion curve actually show the characteristics of a general cohesion. It is only on the basis of this superposability of molecular forces that it is possible to explain the parallelism which has often been observed between the van der Waals deviations of real gases, heats of vaporization, heats of absorption, and other manifestations of molecular forces. It became possible to determine the heats of sublimation of molecular lattices, heats of absorption of absorbed gases and dissociation energies of molecules held together by van der Waals forces. Author

N68-18496# European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center.

A NUMERICAL APPROACH TO THE TIME-DEPENDENT DIFFUSION EQUATIONS

A. Colonelli Daneri (Applicazioni E. Ric. Sci., Milan (Italy), A. Daneri (Applicazioni E Ric. Sci. Milan (Italy), and I. Galligani Brussels Jan. 1968 26 p refs

(Contract EURATOM-040-66-5 CETI)

(EUR-3742.E) CFSTI: HC $3.00/MF $0.65

This report is concerned with a numerical method for the solution of the time-dependent neutron diffusion equations, which is well adapted to describe accurately very fast transients. The convergence of some iterative methods which determine the approximate solution of the neutron diffusion equations is proved. Author

N68-18523# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.

ASYMPTOTIC SU(3) SYMMETRY, CABIBBO ANGLES, AND SUM RULES FOR THE CONSTANTS OF PSEUDOSCALAR MESONS WITH BARYONS [ASIMPTOTICHESKAYA SU(3)-SIMMETRIYA, UGLY KABIBBO I PRAVILA SUMM DLYA KONSTANT SVYAZI PSEVDOSKALYARNYKH MEZONOV S BARIONAMI]

S. B. Gerasimov 1967 6 p refs In RUSSIAN Submitted for publication

(JINR-P2-3555)

The dispersion sum rules for the form factors of the weak baryon current are considered under the assumption of the asymptotic validity of SU(3) symmetry at large momentum transfers and when the effect of the nearest poles in t-channel is predominant. The relations between the coupling constants of pseudoscalar mesons with baryons are discussed. Author (NSA)

N68-18561# Oak Ridge National Lab., Tenn. Neutron Physics Div.

NEUTRON TRANSPORT STUDIES IN DUCTS AND SIMPLE SHIELDS: COMPARISON OF MONTE CARLO AND DISCRETE ORDINATES CALCULATIONS WITH EXPERIMENTAL RESULTS FROM THE TOWER SHIELDING FACILITY

C. E. Clifford, F. J. Muckenthaler, R. E. Maerker, E. A. Straker, and F. R. Mynatt 6 Oct. 1967 55 p refs Presented at the Intern. Conf. on the Phys. Probl. of Reactor Shielding, Harwell, Engl., 26–29 Sep. 1967

(Contract W-7405-ENG-26; DASA Order EO-802-65; DASA Order EO-800-64)

(ORNL-TM-1965; CONF-670932-3) CFSTI: HC $3.00/MF $0.65

A development program for neutron transport calculational techniques has included a series of experiments at the Tower Shielding Facility to measure neutron dose distributions in ducts and neutron energy spectra transmitted through simple shields. The experiments have been used to guide the development of a simplified Monte Carlo method for calculating neutron transmissions through ducts and to guide the development of the discrete ordinates techniques. Measurements of neutron spectra at specific emergent angles from slab shields of polyethylene and lead have been used to verify the discrete ordinates techniques and to aid in the selection of calculational parameters (space, angle and energy meshes, and order of Legendre expansion of the differential scattering cross sections) for use in a two-dimensional code that has recently been developed at Oak Ridge. Cross sections for use in the above neutron transport calculations have been selected on the basis of measurements of the uncollided neutron spectra through thick samples of shield materials. Author (NSA)

N68-18569# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.

ON SPECIFIC CHARACTER OF CASCADE CALCULATIONS OF SOME PROCESSES [O SPETSIFIKE KASKADNYKH RASCHETOV NEKOTORYKH PROTSESSOV]

V. D. Toneev 1967 6 p refs In RUSSIAN

(JINR-P2-3562)

The problem of increasing the counting efficiency for some processes of fast particle interactions with the nucleus is considered. A specific technique is suggested for calculation of double charge-exchange of mesons on nuclei, strange particle production and for calculation of superhigh-energy collisions. Author (NSA)

N68-18573# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.

TO THE SAMPLING PROBLEM OF AN ELEMENTARY ACT OF INTERACTION AT THE INTRANUCLEAR CASCADE CALCULATION [K VOPROSU O ROZYGRYSHE ELEMENTARNOGO AKTA VZAIMODEISTVIYA PRI RASCHETAKH VNUTRIYADERNOGO KASKADA]

V. D. Toneev 1967 7 p refs In RUSSIAN

(JINR-P2-3561)

A method for sampling the characteristics of inelastic πN- and NN-interactions, when calculating fast particle interaction with the nucleus in terms of cascade theory, is treated. The method suggested exactly takes into account both the conservation of energy principle and the law of momentum conservation. Author (NSA)

N68-18574# Technische Hochschule Hannover (West Germany). Arbeitsgruppe fuer Bautechnischen Strahlenschutz.
TABLES OF TOTAL GAMMA ATTENUATION COEFFICIENTS OF THE ELEMENTS AT 0.01 MEV TO 100 MEV [TABELLEN DER TOTALEN GAMMA SCHWAECHUNGSKOEFFIZIENTEN DER ELEMENTE 0,01 MEV-100 MEV]
S. Sasse Jul. 1967 28 p refs In GERMAN
(ABS-THH-1040)

The total γ attenuation coefficients were extrapolated from the values for 22 elements experimentally determined by Hubbell and Berger. The results are tabulated. NSA

N68-18575# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy.
NEGATIVE PION-NUCLEON INTERACTIONS AT 3.85 GEV/C MOMENTUM [VZAIMODEISTOIYA π-MEZONOV S NUKLONAMI PRI IMPUL'SE 3.85 GEV/C]
G. G. Beznogikh, N. F. Truskova, and B. A. Shakhbazyan 1967 27 p refs In RUSSIAN Submitted for publication
(JINR-P1-3563)

The results of investigations of negative pion–nucleon interaction at 3.85 GeV/c momentum using nuclear emulsions in strong magnetic fields are given. A pronounced asymmetry of secondaries in angular distributions in cms for three-prong events is revealed. This phenomenon can be due to coherent interaction processes of primary pions with nuclear substructures. Author (NSA)

N68-18576# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
SU(3) SYMMETRY AND CHIRAL DYNAMICS OF PSEUDOSCALAR MESONS [SU(3)-SIMMETRIYA I KIRAL'NAYA DINAMIKA PSEVDOSKALYARNYKH MEZONOV]
B. V. Struminskii 1967 8 p refs In RUSSIAN
(JINR-P2-3554)

A phenomenological Lagrangian for pseudoscalar meson is obtained which is invariant with respect to the chiral group $U(3) \times U(3)$. Author (NSA)

N68-18601# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
FAITHFUL REPRESENTATIONS OF ALGEBRAS OF TEST FUNCTIONS
G. Lassner and A. Uhlmann 1967 9 p refs
(JINR-E2-3583)

It is shown that the topological *-algebra of test functions for Wightman fields can be faithfully represented as an algebra of (unbounded) operators in a separable Hilbert space. Author (NSA)

N68-18602# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
ASYMPTOTIC BEHAVIOR OF THE VERTEX FUNCTION IN THE THEORY OF NONRENORMALIZABLE CP-NONINVARIANT INTERACTION OF PHOTONS WITH SPINOR PARTICLES
B. A. Arbuzov, N. M. Atakishiev, and A. T. Filippov 1967 12 p refs
(JINR-E2-3557)

The ladder approximation for the vertex function in a nonrenormalizable CP-violating theory is considered. In the Euclidean domain of the momentum the asymptotics of the exact solution and the exact solution itself (for zero fermion mass) are found. The vertex function in the pseudoeuclidean domain of momenta is obtained by analytic continuation of the exact solution. The function possesses usual analytic properties: it decreases along space-like directions of the momentum and increases along time-like ones. Since the imaginary part of the vertex function on the cut exponentially increases it is impossible to write for it a dispersion relation with finite number of subtractions. Author (NSA)

N68-18603# Lyon Univ. (France).
STUDY OF FOCUSING IN ELECTROSTATIC ACCELERATORS OF VERY HIGH CHARGE [ETUDE DE LA FOCALISATION DANS LES ACCELERATEURS ELECTROSTATIQUES A TRES FORT DEBIT]
Guy Burnot (Ph.D. Thesis) Oct. 1967 120 p refs In FRENCH
(LYCEN-6767)

The space charge effect in beams with revolution symmetry is studied. In order to complete the works of M. Barat, an application is made to Van de Graaff accelerator. The method of presenting the problem when the beam is no longer circular but elliptical is studied. An approximate study is of the focusing obtained with an electrostatic tube equipped with quadrupole magnetic lens. The resolution of equations defining the marginal trajectories of a nonrevolution beam is made more rigorous and more systematic. An analytical perturbation method is defined and its results compared with numerical calculations. These methods are applied and tested on various simple cases and particularly on the electrostatic tube equipped with quadrupole magnetic lens. The characteristic of a device permitting the efficient focusing of very intense beams is presented. NSA

N68-18604# Gosudarstvennyi Komitet po Ispolzovaniyu Atomnoi Energii, Moscow (USSR). Institut Teoreticheskoi i Eksperimental'noi Fiziki.
A STUDY ON P–D ELASTIC SCATTERING AT LARGE ANGLES IN THE ENERGY INTERVAL OF 1 TO 3.5 GEV [ISSLEDOVANIE UPRUGOGO P–D RASSEYANIYA NA BOL'SHIE UGLY V OBLASTI ENERGII 1-3,5 GEV]
Yu. D. Bayukov, N. G. Birger, and V. S. Borisov 1966 8 p refs In RUSSIAN; ENGLISH summary
(ITEF-477)

Differential cross-sections of p–d elastic scattering at large angles (θ c.m. $\geq 150°$) were measured in the energy interval 1–3.5 GeV. Results are compared with pole model predictions. Author (NSA)

N68-18605# Gosudarstvennyi Komitet po Ispolzovaniyu Atomnoi Energii, Moscow (USSR). Institut Teoreticheskoi i Eksperimental'noi Fiziki.
ON THE TOTAL ANNIHILATION CROSS SECTION OF ELECTRON POSITRON PAIRS INTO HADRONS AT HIGH ENERGIES
V. N. Gribov, B. L. Ioffe, and I. Ya. Pomeranchuk 1967 8 p refs
(ITEF-493)

The asymptotic behavior of the total cross section of the $e^+ + e^- \rightarrow$ hadrons at high energies is investigated. It is shown that at high $E\sigma \approx \text{Const}/E^2$, where $E-$ are the energies of e^+ and e^- in cms. Author (NSA)

N68-18613# California Inst. of Tech., Pasadena.
STELLAR COMPOSITION AND NUCLEAR PROCESSES Final Report, 1 Jan. 1964–15 Oct. 1967
Jesse L. Greenstein Dec. 1967 17 p refs
(Contract AF 49(638)-1323)
(AFOSR-68-0124; AD-664067) CFSTI: HC $3.00/MF $0.65

This research involved studies on the composition of peculiar stars and the interpretation of the results in light of the current, rapidly changing ideas on the evolution of stars and nucleosynthesis. Specific studies included emphasis on hot stars, including those with magnetic fields, on sub-luminous stars, white dwarfs and highly evolved objects. More recent studies involved cooler, red giant

stars of strange composition, to study isotope ratios of the metals affected by neutron capture, using molecular bands, and including laboratory studies of certain isotope-enriched compounds that may be found in stars. Author (TAB)

N68-18621# Laboratoire de Physique Theorique et des Hautes Energies, Orsay (France).
BACKWARD PION–NUCLEON SCATTERING AND FERMION EXCHANGE MECHANISMS
A. P. Contogouris, J. Tran Thanh Van, and M. Le Bellac (Lab. de Physique Theorique, Nice, France) Dec. 1967 13 p refs
(TH-236)

It is shown that interference of the N_α and N_γ fermion trajectories offers an alternative explanation of the dip observed in the high-energy backward π^+p differential cross sections at $u \simeq -0.15$ (GeV/c)^2. It is also shown that this mechanism predicts a nucleon polarization P which, in general, oscillates as a function of u and attains rather large values ($|P| \geq 0.35$); this is in contrast with the mechanism of dominance by N_α exchange, which at high energy necessarily leads to a small $P(\leq 0.1)$, smoothly varying with u. Author

N68-18622 Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
$^6He_{\Lambda\Lambda}$ WITH NONLOCAL SEPARABLE INTERACTIONS WITH HARD SHELL $\Lambda\Lambda$ REPULSION [ZAGADNIENIE $^6He_{\Lambda\Lambda}$ Z NIELOKALYNYMI SEPAROWALNYMI POTENCJALAMI ZE SZTYWNYM ODPYCHAJACYM RDZENIEM Λ–Λ]
J. Dabrowski, M. Dworzecka, and E. Trych 1967 18 p refs
(INR-831/7/PL)

The problem of $^6He_{\Lambda\Lambda}$ treated as a $2\Lambda+\alpha$ system is solved exactly with a Yamaguchi nonlocal separable Λ –α potential, $V_{\Lambda\alpha}$, and a nonlocal separable Λ–Λ potential, $V_{\Lambda\Lambda}$, consisting of a long range attractive part plus a repulsive shell of radius c. The parameters of $V_{\Lambda\alpha}$ and $V_{\Lambda\Lambda}$ are adjusted to make the potentials equivalent to the local potentials $V_{\Lambda\alpha}$ and $V_{\Lambda\Lambda}$ (with hard core radius r_c) discussed recently by Tang and Herndon. Numerical results for $B_{\Lambda\Lambda}$ ($^6He_{\Lambda\Lambda}$) show that to get agreement with the experimental value of $B_{\Lambda\Lambda}$ one has to choose $c<r_c$. Author

N68-18623# Gosudarstvennyi Komitet po Ispolzovaniyu Atomnoi Energii, Moscow (USSR). Institut Teoreticheskoi i Eksperimental'noi Fiziki.
A STUDY ON THE CHARACTERISTICS OF THE A_2–MESON IN THE π^-p INTERACTION AT A PULSE OF 3.25 GeV/s [IZUCHENIE KHARAKTERISTIK A_2–MEZONA V π^-p VZAIMODEISTVII, PRI IMPUL'SE 3,25 GeV/s]
I. A. Vetlitskii, V. V. Vladimirskii, and V. K. Grigor'ev 1967 24 p refs In RUSSIAN; ENGLISH summary
(ITEF-497)

Using the 55-cm hydrogen bubble chamber exposed to the π^--mesons beam at 3,25±0.02 GeV/c 160.000 photographs were obtained and 2104 events of the reactions of the type $\pi p \rightarrow \pi p \pi^+ \pi^-$ and 1766 events of the reactions type $\pi^- p \rightarrow \pi^- p \pi^+ \pi^- \pi^+$ were selected and analyzed. In the spectrum of the effective masses of $\pi^+\pi^-\pi^-$ system from the first reaction A_2-mesons were selected and the analysis was made by the different methods to determine a spin-parity of this resonance. The second reaction was used to study $\pi\eta$-decay mode of the A_2-meson. Author (NSA)

N68-18624# Gosudarstvennyi Komitet po Ispolzovaniyu Atomnoi Energii, Moscow (USSR). Institut Teoreticheskoi i Eksperimental'noi Fiziki.
CHARGE ASYMMETRY IN $K^0 \rightarrow \pi^+ + \pi^- + \pi^0$ [ZARYADOVAYA ASIMMETRIYA V RASPADAKA $K^0 \rightarrow \pi^+ + \pi^- + \pi^0$]
B. Ya. Zel'dovich 1967 12 p refs In RUSSIAN; ENGLISH summary
(ITEF-516)

The decays of neutral K-mesons into $\pi^+\pi^-\pi^0$ are discussed in connection with the selection rules in isotopic spin T and CP-invariance. The expressions of the isotopic amplitudes of the decay are given taking into account three pions final-state interactions. Special attention is paid to the estimates of the value R of the charge asymmetry. Interference of CP-even amplitudes $K_2 \rightarrow (3\pi, T=1)$ and $K_1 \rightarrow (3\pi, T=2)$ in the K^0 decay close to its production point may result in the value $R \approx 10^{-1}+10^{-2}$. Charge asymmetry in the K_L-meson decay is proportional to the CP-odd amplitude $K_L \rightarrow (3\pi, T=2)$, its value depends on the isotopic properties of the CP = –1 interaction. A large charge asymmetry (up to 30%) is predicted in the pure $K_S \rightarrow \pi^+\pi^-\pi^0$ decay, but the probability of this decay must be very small. Author (NSA)

N68-18693# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
SUPERFLUID NUCLEUS PROPERTIES IN THE REGION FROM 100 TO 256 A [SVERKHTEKUCHIE SVOÍSTVA YADER V OBLASTI 100 lt A lt 256]
V. P. Garistov and I. D. Khristov 1967 33 p refs In RUSSIAN
(JINR-P4-3584)

Pairing energies for spherical and deformed nuclei (in the region $100 < A < 256$) are calculated on the basis of superfluid nucleus model. The Nilsson scheme is chosen as one-particle equations of an average field. The pairing energies, calculated with the constants G_N=23 A^{-1}, G_Z=27 A^{-1} in the $150 < A < 256$ region and G_N = 17 A^{-1}, G_z = 20 A^{-1} in the $100 < A < 150$ region, agree sufficiently well with the experimental data. The correlation functions and chemical potentials are obtained. The data obtained can be used for estimations of many physical processes in medium and heavy nuclei. Author (NSA)

N68-18707# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
ISOBARIC ANALOGUE RESONANCES IN NUCLEI OF CLOSED NEUTRON SHELLS
P. Beregi and I. Lovas 1967 36 p refs Submitted for publication
(JINR-E2-3551)

The scattering amplitude of the elastic proton scattering is investigated in the energy range of the isobaric analog resonances. The scattering amplitude is expressed as $J=J^{opt}+J^{res}$, where the background term J^{opt} is calculated by means of the standard optical model, and the resonance term is derived using Feshbach's projection operator method. The "ideal" isobaric analog states (IAS) are introduced by applying the stepdown isospin operator T_- on the wave functions of the low-lying states of the target + neutron system. Afterwards the "target ground state + proton" component of the "ideal" IAS is projected out. Such a doorway-type state, the so-called "projected" IAS is assumed to play the role of the intermediate state of the scattering process. The method is applied for the calculation of the cross section and polarization of elastic proton scattering on ^{138}Ba, ^{140}Ce, and ^{142}Nd. The low-lying states of the target are calculated in the framework of the quasiparticle random phase approximation and the wave functions for the target + neutron system are obtained by diagonalizing the residual interaction in the quasiboson + single neutron basis. Author (NSA)

N68-18708# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics.
NEUTRON RESONANCES OF NEODYMIUM ISOTOPES [NEITRONNYE REZONANSY IZOTOPOV NEODIMA]

E. N. Karzhavina, Nguyen Nguyen Phong, A. B. Popov, and A. I. Taskaev 1967 23 p refs In RUSSIAN Submitted for publication (JINR-P3-3564)

On a neutron spectrometer, measurements were performed of transmission and yields of γ ray from the neutron capture for the natural neodymium samples and for those enriched by ^{142}Nd, ^{143}Nd, ^{144}Nd, ^{145}Nd, ^{146}Nd, ^{148}Nd, and ^{150}Nd isotopes. The ^{143}Nd and ^{145}Nd isotopes were studied in the energy region up to 100 eV, while the other isotopes were studied in the region up to 10 keV. The following values of distance between the levels D: 1000±250, 38±6, 520±70, 20±3, 310±43, 200±21, and 230±28 are obtained for the isotopes ^{142}Nd, ^{143}Nd, ^{144}Nd, ^{145}Nd, ^{146}Nd, ^{148}Nd, and ^{150}Nd, respectively, as well as the values of strength function S_0: $0.6\pm0.3\times10^{-4}$; $4.3\pm1.4\times10^{-4}$; $4.8\pm2.0\times10^{-4}$; $3.0\pm0.7\times10^{-4}$; $4.5\pm1.9\times10^{-4}$; $3.6\pm1.1\times10^{-4}$; and $2.0\pm0.8\times10^{-4}$ Author (NSA)

N68-18715# Miami Univ., Coral Gables, Fla. Center for Theoretical Studies.

R_4 INVARIANTS FOR DOUBLY EXCITED STATES OF HELIUM

Carl E. Wulfman Feb. 1968 10 p refs Sponsored in part by NSF

(CTS-TC-68-1)

The group R_4 provides two new invariants that usefully label those helium metastable states in which, to first approximation, both electrons are in the second quantum level. Author

N68-18723# Uppsala Univ. (Sweden). Quantum Chemistry Group.

QUANTUM THEORY OF MANY PARTICLE SYSTEMS Final Report, 1 Sep. 1965–31 Aug. 1967

31 Aug. 1967 21 p refs

(Contract AF 61(052)-874)

(AFOSR-68-0100; AD-664073) CFSTI: HC $3.00/MF $0.65

A brief summary is given of research directed towards the investigation of the electronic structure of atoms, molecules, and solidstate by means of quantum-mechanical methods. Results of particular importance have been obtained with respect to infinite-order perturbation theory, upper and lower bounds to energy eigenvalues, properties of density matrices, and the general understanding of many-body systems and the correlation problem. Applications were carried out to study the properties of various systems, including light atoms, comparatively small molecules, very large molecules, alkali halides, and alkali metals. Large-scale computations were carried out on the CD 3600 electronic computer available at Uppsala University. TAB

N68-18738# Uppsala Univ. (Sweden). Quantum Chemistry Group.

ELEMENTARY EXCITATIONS IN PI-ELECTRON MOLECULES

Jan Linderberg and Yngve Oehrn 1 Apr. 1967 24 p refs

(Contract AF 61(052)-874)

(SR-31; AFOSR-68-0118; AD-664072) CFSTI: HC $3.00/MF $0.65

Equations of motion for the single particle propagator are decoupled in an atomic approximation for the Pariser-Parr-Pople model for conjugated systems. The solution is correct in the limit of separated atoms for a homonuclear two-center two-electron system. Author (TAB)

N68-18809# Southampton Univ. (England). Dept. of Aeronautics and Astronautics.

AN APPROXIMATE NUMERICAL SOLUTION FOR FRANCK–CONDON FACTORS AND R-CENTROIDS APPLIED TO THE FIRST POSITIVE SYSTEM OF N_2

R. E. W. Jansson and B. E. Cunio (Central Elec. Generating Board) Nov. 1967 21 p refs

(AASU-274)

The method of Fraser and Jarmain for the calculation of Franck–Condon factors from Morse potential functions has been adapted for accurate machine computation. Using the latest molecular data for the first positive system of N_2, extremely good agreement with more rigorously calculated R.K.R. values has been obtained up to moderately high quantum numbers. Calculations of r-centroids have also been made, both directly, through the definition of the r-centroid, and by the quadratic approximation. Agreement between the two methods is good where the overlap of wavefunctions is reasonably large. The new values of the r-centroids differ considerably from those previously quoted in the literature. Author

N68-18835*# Aztec School of Languages, Inc., Acton, Mass.

ENERGY LEVELS AND FILLING SEQUENCES

V. M. Klechkovskiy Mar. 1968 11 p refs Transl. into ENGLISH from Zh. Eksperim. Teor. Fiz. (Moscow), v. 23, no. 1(7), 1952 p 115–122

(Contract NASw-1692)

(NASA-TT-F-11490) CFSTI: HC $3.00/MF $0.65 CSCL 20H

The general rule of sequential (with increasing atomic number) filling of quantum levels by electrons is examined. It is shown that this rule can be determined by grouping levels on the basis of the sum of the principal and orbital quantum numbers. Author

N68-18854# Atomic Energy of Canada, Ltd., Chalk River (Ontario).

ENUMERATION OF MANY BODY STATES OF THE NUCLEAR SHELL MODEL WITH DEFINITE ANGULAR MOMENTUM AND ISOBARIC SPIN WITH MIXED SINGLE PARTICLE ORBITS. j=1/2, 3/2: 1/2, 3/2, 5/2: 1/2, 3/2, 5/2, 7/2: 7/2, 3/2

T. Sebe and M. Harvey Jan. 1968 26 p refs

(AECL-3007) Available from Atomic Energy of Canada, Ltd., Chalk River: $1.00

Reported is a study of nuclei of mass $A \leq 60$ which demonstrates how large the shell model problem can become when used to microscopically describe by diagonalization the energy matrix of residual interactions between many body states arising from a given number of particles in a few single particle orbits. Tabulated are the number of many body states of a given angular momentum J and isobaric spin T that can be formed with a given number of particles in mixed single particle orbits $j_1 j_2 \cdots j_k$. Values for natural $2J+1$ and $2T+1$ degeneracy are not listed. Considered are the following: (1) the filling of the oscillator 1p shell; (2) the filling of the oscillator (2s,1d) shell; (3) the filling of the oscillator (2p,1f) shell; and (4) a reasonable assumption of the single particle orbits being filled after mass A=40. Tabulated results justify studies of submodels of the nuclear model, e.g. the jj coupling model, the SU_3 model, or the proposed mixed coupling scheme. Advantages of using submodels are: (1) submodels make drastic assumptions about the effective residual interaction in an attempt to pick out the structure of low energy states without resorting to the diagonalization of the full energy matrix; and (2) submodels attempt to describe more of the physical structure of a shell model state in terms of well defined quantum numbers. S.C.W.

N68-18856# Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf.

THE REACTOR NEUTRON CAPTURE CROSS SECTION OF Sc^{48} AND A DETERMINATION OF THE BETA BRANCHING RATIO OF THE Sc^{47} DECAY

Zong-tschun Bak (Inst. fuer Radiumforsch. und Kernphys.) and P. Riehs [1967] 11 p refs

(SGAE-PH-61/1967) CFSTI: HC $3.00/MF $0.65

The secondary neutron capture cross section for the thermal neutron flux monitor Scandium is determined as 7.7±0.6 b by activity measurements. By means of a 4π-beta-gamma coincidence measurement, the relative intensity of the 160 keV gamma ray of Sc^{47} was found to be 0.68±0.027 per decay. Author

N68-18858# Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf.

THE ANGULAR DISTRIBUTION OF SCATTERED AND SPUTTERED 40 KEV PARTICLES ON POLYCRYSTALLINE TARGETS

E. Formann (Wien Univ.), F. P. Viehboeck, and H. Wotke [1967] 19 p refs Submitted for publication

(SGAE-PH-62/1967) CFSTI: HC $3.00/MF $0.65

Based on the hard sphere potential approximation, angular distributions of scattered particles at different mass ratios $M_1:M_2$ were calculated. The results were compared with experiments carried out with the following atoms: incident ion beam (M_1) Mg, Mg, Mg, Kr, Kr, Kr, Gd, and Gd. Their respective target materials (M_2) were Al, Mo, Ta, Al, Mo, Ta, Al, and Ta. The sputtered particles from the target as well as from the incident ion beam were collected on graphite rods and measured either by activation analysis or a radioactive tracer technique. Author

N68-18864# Los Alamos Scientific Lab., N. Mex.

ELASTIC AND INELASTIC SCATTERING OF FAST NEUTRONS FROM ^{6}Li AND ^{7}Li

John C. Hopkins, D. M. Drake, and H. Conde 21 Nov. 1967 62 p refs

(Contract W-7405-ENG-36)

(LA-3765) CFSTI: HC $3.00/MF $0.65

The differential elastic and inelastic neutron scattering cross sections of ^{6}Li and ^{7}Li were measured at incident neutron energies of 4.83, 5.74, and 7.5 MeV for ^{6}Li and at energies of 3.35, 4.83, 5.74, and 7.5 MeV for ^{7}Li. Scattered neutrons and gamma rays were observed independently. The cross sections were measured with a neutron time-of-flight spectrometer relative to the well-known cross section for neutron scattering from hydrogen. The gamma-ray spectra were measured with a NaI(Tl) spectrometer using time-of-flight techniques to eliminate the neutron background. The 2.184-MeV state in ^{6}Li was excited by neutron inelastic scattering. The 3.56-MeV state in ^{6}Li was not observed in either the neutron or gamma-ray studies. Scattered neutrons from the 0.478-MeV state in ^{7}Li were resolved at both 3.35 and 4.83 MeV. Scattered neutrons from the 4.63-MeV state in ^{7}Li were observed at incident neutron energies of 5.74 and 7.5 MeV. A continuum of neutrons due to three-particle breakup was observed for both ^{6}Li and ^{7}Li at 4.83, 5.74, and 7.5 MeV. Author (NSA)

N68-18867# Los Alamos Scientific Lab., N. Mex.

EXPERIMENTAL DETERMINATIONS OF HALF-LIVES OR MEAN LIVES OF FREE PIONS AND MUONS: A LITERATURE SEARCH

Jean Furnish, comp. 27 Nov. 1967 19 p refs

(Contract W-7405-ENG-36)

(LA-3780-MS) CFSTI: HC $3.00/MF $0.65

A search was made for abstracts relating to experimental determinations of half-lives or mean lives of free mesons (π) and mesons (μ). The abstracts are arranged in rough chronological order by year with the most recent given first. NSA

N68-18882# United Kingdom Atomic Energy Authority, Harwell (England). Research Group.

CRITICAL INELASTIC SCATTERING OF SLOW NEUTRONS FROM A BINARY LIQUID METAL MIXTURE (Bi–Zn)

P. A. Egelstaff and G. D. Wignall Oct. 1967 19 p refs

(AERE-R-5627) HMSO: 3s

An expression for the intensity of coherently scattered radiation from a binary mixture is derived in terms of scattering from the density and concentration fluctuations. It is shown that in the consolution region the scattered intensity is due predominantly to the concentration fluctuations. A preliminary measurement of critical opalescence in liquid metal systems (Bi–Zn) is described using the inelastic scattering of slow neutrons. The spectra are clearly separable into a Q dependent quasi elastic region associated with scattering from the concentration fluctuations of the system, and an inelastic region associated with the interatomic modes of vibration of the system. For the former region no departure from the theory of Ornstein and Zernicke was observed leading to a value of $\eta \approx 0$ for the range of Q observed, 0.05–0.9 $Å^{-1}$. At values of Q beyond 0.9 Å the Ornstein–Zernicke theory does not describe the scattering. It is shown how the critical indices, γ, ν and δ may be obtained from scattering data and a future experimental program is outlined. Author

N68-18888 Yale Univ., New Haven, Conn.

DECAY PROPERTIES OF NEUTRON DEFICIENT ISOTOPES IN THE XENON–BARIUM MASS REGION

John Michael D'Auria (Ph.D. Thesis) 1967 251 p

Available from Univ. Microfilms: HC $11.50/MF $3.25 Order No. 67-7004

Heavy ion induced reactions were utilized in the search for and study of the presence of isomerism in Ba^{125}. Standard radiochemical techniques were used to separate the neutron deficient reaction products formed from the reaction of C^{12}, N^{14}, and O^{16} heavy ions with targets of natural indium and antimony. The radioactive decay of Ba^{125} as well as surrounding nuclides were studied, exploiting various techniques of nuclear spectroscopy. Information is also presented on the search for delayed proton emission from the isotope, Ne^{17}. Dissert. Abstr.

N68-18898# United Kingdom Atomic Energy Authority, Harwell (England). Research Group.

SCATTERING LAW S(α,β)-VALUES FOR GRAPHITE AT 1300°K AND 1800°K

D. I. Page Nov. 1967 28 p refs

(AERE-R-5574) HMSO: 4s

The differential scattering cross sections of graphite at 1300°K and 1800°K have been measured for neutrons of 0.101 eV and 0.054 eV (1800°K only) incident energy. The results are given as tables of Scattering Law S(α,β)-values derived directly from the experimental data. The values cover ranges of energy and momentum transfers of 0 to 0.4 eV and 1 to 19 $Å^{-1}$ respectively. Author

N68-18935# Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires.

FAST NEUTRON SPECTROMETRY USING TIME OF FLIGHT [SPECTROMETRIE DE NEUTRONS RAPIDES PAR TEMPS DE VOL]

Francoise Bertrand and Jacques Voignier Sep. 1967 30 p refs In FRENCH

(CEA-R-3254)

A thorough investigation of fast neutron time-of-flight spectrometry was made. The neutrons were obtained by the T(d,n)α reaction, and the time-of-flight was determined by the associated-particle method. A time resolution of 0.94 nanosec and an energy resolution of 5.6% were achieved. NSA

N68-18937# Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.

SUPER HIGH ENERGY INTERACTIONS IN LARGE BLOCKS OF PHOTOGRAPHIC EMULSION

Z. Czachowska, J. Gierula, S. Krazywdzinski, M. Miesowicz, K. Rybicki et al 1967 17 p
(INR-P-826/6/PH)

A review of some results on super-high energy interactions obtained from the ICEF and Brawley emulsion stacks is presented. The determination of the proton–nucleon elastic cross section in the TeV region, detailed experimental analysis of nucleon–nucleon collisions between 10^{12} and 10^{14} eV, coherent production of particles in collisions of 200-GeV mesons (π) with emulsion nuclei, and meson (π) interactions at 200 GeV are covered. The results given in general confirm multiple production by the emission of fireballs with the preservation of individuality of the incident particle. Also some information is obtained on other processes such as elastic scattering and meson (π) interactions including coherent production. NSA

N68-18938# Polish Adademy of Sciences, Warsaw. Inst. of Nuclear Research.
FISSION-LIKE DISINTEGRATIONS OF MEDIUM-MASS NUCLEI INDUCED BY HIGH-ENERGY PROTONS
E. Makowska, J. Sieminska, and J. Suchorzewska 1967 34 p refs
(INR-P-827/6/PH)

The analysis of 788 fission-like interactions of the 25-GeV/c protons with Ag and Br nuclei in low-sensitivity emulsion was done. Several possible models which might describe these interactions are analyzed, and a new model is discussed on the assumption that the target nucleus breaks up in an explosion. Author (NSA)

N68-18949*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A CRITICAL EVALUATION OF THE USE OF ULTRASONIC ABSORPTION FOR DETERMINING HIGH-TEMPERATURE GAS PROPERTIES
Warren F. Ahtye Washington Mar. 1968 70 p refs
(NASA-TN-D-4433) CFSTI: HC $3.00/MF $0.65 CSCL 20M

The usefulness of ultrasonic absorption for determining the values of high-temperature gas properties has been examined critically. The sources of ultrasonic absorption considered are: viscosity and thermal conductivity (classical absorption), thermal radiation, and relaxation effects due to dissociation, ionization, and electronic excitation by atomic collisions. The absorption values for argon and nitrogen were calculated in an attempt to explain the large disparity between classical values and those measured by Carnevale in a series of electric arc experiments. Ultrasonic absorption in oxygen and in hydrogen was also examined. The calculations show that it is possible to measure the transport coefficients of argon and hydrogen for two states. The transport coefficients of nitrogen and oxygen cannot be measured with any degree of accuracy at any temperature. The calculations show that the ultrasonic absorption associated with thermal radiation is so minute that the absorption technique is incapable of measuring total radiative intensities of atmospheric gases even at temperatures sufficiently high that single ionization occurs. It is shown that most of the anomalous absorption in nitrogen can be attributed to collisional excitation of the bound electrons in nitrogen atoms, but only if a high collisional efficiency exists. Author

N68-18968# California Inst. of Tech., Pasadena.
INTERNAL CONVERSION TABLES. PART 1: K,L,M SHELL CONVERSION COEFFICIENTS
R. S. Hager and E. C. Seltzer Jun. 1967 160 p refs
(Contract AT(04-3)-63)
(CALT-63-60) CFSTI: HC $3.00/MF $0.65

Calculations of K-, L-, and M-shell conversion coefficients were performed for nuclei with Z from 30 to 103 taking into account the four lowest electric and magnetic multipoles. The energies of the continuum electron ranged from 1 to 1500 keV for the K shell, from 1 to 1000 keV for the L shell, and from 1 to 500 keV for the M shell. The coefficients are presented as a function of the continuum electron energy, the continuum electron momentum, and the gamma-ray transition energy. NSA

N68-18970# Laboratoire de Physique Theorique et des Hautes Energies, Orsay (France).
DERIVATION OF NONRELATIVISTIC SUM RULES FROM CAUSALITY
K. Chadan and A. Montes Oct. 1967 52 p refs
(TH/219) CFSTI: HC $3.00/MF $0.65

Nonrelativistic sum rules obtained previously in the framework of elastic scattering by a local potential are shown to follow from the Causality Principle of Wigner and Van Kampen. It is shown in fact that under the mild and plausible assumption that the phase shift, in the limit of high energy, goes to a multiple of π such as to satisfy conditions and the Levinson theorem, the causality condition is equivalent to assuming a local potential inside the interaction region. In other words, it is shown that any interaction which is causal and for which the Levinson theorem holds is equivalent to a local potential of radius R. Author

N68-18972# Laboratoire de Physique Theorique et des Hautes Energies, Orsay (France).
ON SOME SINGULARITIES OF THE REGGE POLE MODEL AT MASS ZERO
R. Omnes Nov. 1967 9 p refs
(TH/228) CFSTI: HC $3.00/MF $0.65

The behavior of a Regge pole expansion is considered when the mass of a physical particle tends to zero. If this variation of the mass is obtained by letting some parameter λ vary, it is found that the analytic form of the residues must change discontinuously when the mass passes through zero. Some consequences are given, concerning the reliability of perturbation expansion, zero mass pions, and their Toller classification, the Pomeranchuk singularity. Author

N68-18981*# Oak Ridge National Lab., Tenn. Radiation Shielding Information Center.
BIBLIOGRAPHY, SUBJECT INDEX, AND AUTHOR INDEX OF THE LITERATURE EXAMINED BY THE RADIATION SHIELDING INFORMATION CENTER—SPACE AND ACCELERATOR SHIELDING
J. Gurney, ed. Sep. 1967 119 p refs Revised Supersedes ORNL-RSIC-11 See N66-26815
(NASA Order R-104(10))
(NASA-CR-75316; ORNL-RSIC-11, Rev. 1, ORNL-RSIC-11) CFSTI: HC $3.00/MF $0.65 CSCL 18F

A listing is presented of approximately 400 articles on space radiation sources, cross section data, particle transport, and shielding. NSA

N68-18982# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
INFINITE MULTIPLETS IN QUANTUM FIELD THEORY [BESKONECHNYE MUL'TIPLETY V KVANTOVOI TEORII POLYA]
Dao Vong Dyc, Cao Chi, and Nguyen Van Hieu 1967 47 p refs In RUSSIAN
(JINR-P2-3606)

Some previously obtained essential results in quantum field theory with infinite multiplets are treated. The explicit expression of the matrix of finite Lorentz transformation is found. The

interaction of infinite multiplets is studied and its specific properties are shown. The quantization of fields with infinite multiplets is considered and the existence of big free local fields with normal connection between spin and statistics is shown. The generalized Feynman rules are formulated. Author (NSA)

N68-19008# Forsvarets Forskningsanstalt, Stockholm (Sweden).
PROMPT ANTI-NEUTRINO IN NEUTRON-INDUCED FISSION OF ^{239}Pu AND ^{241}Pu
H. Conde, J. Hansen, and M. Holmberg Oct. 1967 15 p refs
(FOA-4-4318-22)

The energy dependence of prompt $\bar{\nu}$ was investigated for the neutron-induced fissions of ^{239}Pu and ^{241}Pu. The fission neutron detector was a large liquid scintillator, and $\bar{\nu}$ for the spontaneous fission of ^{252}Cf was used as a standard. The measurements of ^{239}Pu and ^{241}Pu were made at incident neutron energies between 4 and 14.8 MeV and 0.5 and 14.8 MeV, respectively. The best fit of the present data for ^{239}Pu and ^{241}Pu are the lines $\bar{\nu}(E_n) = 2.91 + 0.141\ E_n$ (MeV) and $\bar{\nu}(E_n) = 2.91 + 0.146\ E_n$ (MeV) based on $\bar{\nu} = 3.766$ for ^{252}Cf. Author (NSA)

N68-19012# Paris Univ., Orsay (France).
THEORY ON N-BODY NUCLEAR REACTIONS AND APPLICATION TO FOUR BODY PROBLEMS
J. L. Ballot and F. Becker [1967] 36 p refs
(IPNO/TH-102)

A theory of nuclear reactions based on a second-quantization formalism is used to derive the different equations for the N-body direct nuclear reactions. Then, setting N = 4 the integral equations for the 4-body problem are explicitly given for (D–D), (T–N) and (^{3}He–N) elastic and inelastic scattering. Author (NSA)

N68-19031# Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires.
CONTRIBUTION TO THE STUDY OF LOW-ENERGY (d,p) REACTIONS ON LIGHT NUCLEI [CONTRIBUTION A L'ETUDE DES REACTIONS (d,p) A BASSE ENERGIE SUR NOYAUX LEGERS]
Nguyen Van Sen (Ph.D. Thesis—Grenoble Univ.) 20 May 1967 88 p refs In FRENCH
(CEA-R-3305)

The analysis of (d,p) reactions at energies <3 MeV using the plane-wave, distorted-wave, and Coulomb-wave Born approximations was investigated; and the results were applied to some experimental data on the ^{9}Be(d,p)^{10}Be, ^{22}Ne(d,p)^{23}Ne, ^{14}N(d,p)^{15}N, and ^{16}O(d,p)^{17}O reactions that indicated a direct mechanism. The first three reactions were treated as stripping, while the ^{16}O(d,p)^{17}O reaction was treated in terms of interference between stripping and compound-nucleus formation. NSA

N68-19032# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions.
CHARGED PARTICLE DETECTION WITH THE AID OF CELLULOSE NITRATE [REGISTRATSIYA ZARYAZHENNYKH CHASTITS S POMOSHCH'YU NITRATA TSELLYULOZY]
Kh. Abdullaev, V. P. Perelygin, S. P. Tret'yakova, and N. Kh. Shadieva 1967 9 p refs In RUSSIAN
(JINR-P13-3585)

The technique for detection of light charged particles with the aid of cellulose nitrate is developed. The threshold of response of cellulose nitrate to α-particles is determined to be $\leq$2.2 MeV, and the detection efficiency—(90±7)%. The possibilities of using the cellulose nitrate detectors for the detection of heavy charged particles and for measurement of Li and B contents in matter are considered. Author (NSA)

N68-19033# Polish Academy of Sciences, Cracow. Inst. of Nuclear Physics.
ELASTIC AND ALMOST ELASTIC PROTON–DEUTERON SCATTERING AT HIGH ENERGIES
W. Czyz and L. Lesniak 1967 9 p refs
(INP-575/PL/PH)

The contribution of inelastic processes to the proton–deuteron scattering cross section with a given energy resolution is estimated. Author (NSA)

N68-19034# Polish Academy of Sciences, Warsaw.
ABSOLUTE MEASUREMENT ON THE LONGITUDINAL POLARIZATION OF BETA RAYS FROM ISOTOPES: ^{46}Sc, ^{137}Cs, AND ^{204}Tl [IZMERENIE ABSOLYUTNOI VELICHINY POLYARIZATSII ELEKTRONOV POLUCHENNYKH PRI RASPADE IZOTOPOV: ^{46}Sc, ^{137}Cs, ^{204}Tl]
Z. Vil'gel'mi, I. Volovskii, S. Khoinatskii, A. Korman, and A. Plokhotskii 1967 13 p refs In RUSSIAN; ENGLISH summary
(INR-798/I/PL)

The longitudinal polarizations of electrons from the beta decay of the isotopes ^{46}Sc, ^{137}Cs, and ^{204}Tl were compared. The degree of polarization was measured by the asymmetry in the electron scattering in a thin gold foil. Longitudinal electron polarization was transformed into transverse polarization by means of crossed electric and magnetic fields. The measurements were carried out for the electrons of energy E_e = 250 keV. Author (NSA)

N68-19037# Joint Inst. for Nuclear Research, Dubna (USSR).
IS ONE OF THE LEPTON QUANTUM NUMBERS MULTIPLICATIVE? [MUL'TIPLIKATIVNO LI ODNO IZ LEPTONNYKH KVANTOVYKH CHISEL?]
Nguyen van Hieu and B. M. Pontekorvo 1967 6 p refs In RUSSIAN Submitted for publication
(JINR-P2-3601)

A neutrino experiment is suggested which allows one to determine whether a lepton quantum number, which distinguishes between the μ-neutrino and the e-neutrino, is multiplicative or additive. Author (NSA)

N68-19039*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
VARIATIONAL BOUNDS IN POSITRON ATOM SCATTERING
Richard J. Drachman Mar. 1968 57 p refs
(NASA-TM-X-63130; X-641-68-75) CFSTI: HC $3.00/MF $0.65
CSCL 20H

The complete first-order adiabatic correlation function of Dalgarno and Lynn have been applied to the problem of low-energy elastic positron scattering by hydrogen and helium atoms. This approach is now extended to yield rigorous lower bounds on the scattering phase shifts in the case of hydrogen and "quasi-bounds" for helium. In addition, the positron annihilation rate in helium is re-evaluated, and lower values are now found, with the enhancement factor over the Dirac rate varying between 1.5 and 1.8. Some comparisons are made between the present method and other recent work. Author

N68-19054# Argonne National Lab., Ill.
SIMPLE QUASICLASSICAL CORRELATION FOR THE ANGULAR ANISOTROPY OF NUCLEAR FISSION BY NEUTRONS
V. G. Nesterov, G. N. Smirenkin, and A. S. Tishin [1967] 7 p refs Transl. into ENGLISH from Rept. FEI-66
(ANL-TRANS-548) CFSTI: HC $3.00/MF $0.65

An analysis is made of the disagreement between quantum-mechanical calculations of the angular anisotropy of nuclear fission by neutrons and the well-known quasiclassical formula by Halpern and Strutinskii $A=5\ E_n/8\ K_0^2$. A simple semiempirical correlation is derived for the mean square of the angular moment of the nucleus which eliminates this discrepancy. Author (NSA)

N68-19056# Colorado Univ., Boulder. Nuclear Physics Lab.
[ON NUCLEAR PHYSICS] Technical Progress Report
1 Nov. 1967 93 p refs
(Contract AT(11-1)-535)
(COO-535-571) CFSTI: HC $3.00/MF $0.65

The energy levels of several nuclei were investigated using charged-particle reactions and scattering; optical-model fits to the data were made. Thoretical formalisms for nuclear reactions and models were also studied. Self-supporting isotopic targets were prepared using vacuum evaporation, and lithium-drifted detectors were fabricated and tested. NSA

N68-19067# Australian National Univ., Canberra. Research School of Physical Sciences.
ENERGY LEVELS OF ^{16}O IN THE VICINITY OF 13 MEV
J. M. Morris, G. W. Kerr, and T. R. Ophel [1967] 32 p refs
(NP-17203)

Angular distributions and excitation functions of the elastic scattering reaction $^{12}C(\alpha,\alpha_0)$ were analyzed in terms of complex phase shifts for the range of incident alpha particle energies 6.6 MeV $\leq E_\alpha \leq$ 8.4 MeV. The results confirm the presence of four levels in the compound nucleus system ^{16}O at excitation energies of 13.01, 13.08, 13.12, and 13.25 MeV, respectively. Level parameters for the states at 13.01 and 13.12 MeV were deduced with more accuracy than from previous measurements. Author (NSA)

N68-19068# Institute of Nuclear Sciences, Lower Hutt (New Zealand).
REPORT ON THE WORK OF THE INSTITUTE OF NUCLEAR SCIENCES Progress Report, Jan.–Jun. 1967
Jun. 1967 62 p refs
(NP-17190; INS-238; PR-9)

A summary of the work done at the Institute of Nuclear Sciences from January through June 1967 is presented. Discussed are projects in nuclear physics, radiation research, isotope geochemistry–stable isotopes, radioactive dating and radioactive fall-out, isotope applications, and instrumentation. NSA

N68-19079# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
A QUARK MODEL FOR PARITY VIOLATING NON-LEPTONIC DECAYS [MODEL KVARKOV DLYA NELEPTONNYKH RASPADOV, NE SOKHRANYAYUSHCHIKH CHETNOST]
M. K. Aliev and B. V. Struminskii 1967 5 p refs In RUSSIAN Submitted for publication
(JINR-P2-3603)

The quark model is used in order to obtain the relations between the amplitudes of nonleptonic decays of hyperons and mesons. The well known paradox related with $K \rightarrow 2\pi$ decays is resolved. Author (NSA)

N68-19108# Atomics International, Canoga Park, Calif.
A TECHNIQUE FOR COMPUTING THE INVERSE DIFFERENTIAL CROSS-SECTION TRANSFORMATION MATRIX T^{-1}
R. F. Berland 28 Jul. 1967 15 p refs
(Contract AT(04-3)-701)
(NAA-SR-MEMO-12489) CFSTI: HC $3.00/MF $0.65

A technique is presented for computing the inverse differential cross-section transformation matrix T^{-1} directly (also the T matrix itself). Some numerical examples are given to demonstrate the accuracy attained. Author (NSA)

N68-19124 California Inst. of Tech., Pasadena.
AN INVESTIGATION OF THE THREE BODY REACTION $He^3(He^3, 2p)He^4$
Andrew Dow Bacher (Ph.D. Thesis) 1967 199 p
Available from Univ. Microfilms: HC $9.00/MF $3.00 Order No. 67-6977

Reactions produced by the He^3 bombardment of He^3 have been investigated for bombarding energies from 1 to 20 MeV using a tandem Van de Graaff accelerator. Proton spectra from the three-body reaction $He^3(He^3, 2p)He^4$ have been measured with a counter telescope at 13 angles for 9 bombarding energies between 3 and 18 MeV. The results are compared with a model for the reaction which includes a strong p-He^4 final-state interaction. Deuteron spectra from the reaction $He^3(He^3,d)pHe^3$ have been measured at 18 MeV. A triton spectrum from the reaction $He^3(He^3,t)3p$ at 20 MeV and 4° is interpreted in terms of sequential decay through an excited state of the alpha particle at 20.0 MeV. No effects are observed which would indicate an interaction in the residual (3p) system. Dissert. Abstr.

N68-19135 Stanford Univ., Calif.
K-, L-, AND M-SHELL ATOMIC PHOTOEFFECT FOR SCREENED POTENTIAL MODELS
Ronald Dean Schmickley (Ph.D. Thesis) 1967 409 p
Available from Univ. Microfilms: HC $18.45/MF $5.25 Order No. 67-7963

The K-, L-, and M-shell atomic photoeffect total cross sections, differential cross sections, and polarization correlations were numerically calculated for various central potential models of the atom. Calculations to investigate screening effects were made for Thomas–Fermi, Kerner, and Yukawa potentials, and these were compared with Coulomb results. The calculations were made mainly for Z=26, 50, and 92 and for incident photon energies of 412, 662, and 1332 keV. It was found that the effects of a screening on the absolute cross sections could be accounted for by a screening factor equal to the square of the ratio of the bound-state screened to unscreened normalizations. The theoretical explanation of the normalization effect was used to predict realistic total cross sections which compare favorably with experiment. Dissert. Abstr.

N68-19177# Atomics International, Canoga Park, Calif.
NEARREX 2: A CODE FOR COMPOUND NUCLEUS CALCULATIONS
C. L. Dunford 5 Oct. 1967 14 p refs
(NAA-SR-MEMO-12530) CFSTI: HC $3.00/MF $0.65

Compound-nucleus theory is used to analyze the decay of the compound nucleus by such a means as neutron emission, proton emission, fission, etc. Compound-nucleus formation cross sections as well as neutron transmission coefficients are calculated from the optical model. This information combined with capture and fission model parameters serves as input for a statistical theory of the compound nucleus. The computer program NEARREX which performs calculations based on this statistical model has been converted for use on the IBM 360-50, and considerable modifications have been made to meet project requirements. Author (NSA)

N68-19178# Iowa State Univ. of Science and Technology, Ames.
ON THE EFFECTS OF SPIN, SYMMETRY, AND POLARIZATION WHEN AN ISOSINGLET RESONANCE DECAYS TO FOUR PIONS
John Terence Nelson (Ph.D. Thesis) Aug. 1967 60 p refs
(Contract W-7405-ENG-82)
(IS-T-210) CFSTI: HC $3.00/MF $0.65

Phase-space distributions for the decay of an isosinglet resonance into four pions are developed. Such resonances were observed in the final state of the reaction $p + \bar{p} \rightarrow 2\pi^+2\pi\bar{v} + \pi^0$, for example. Of primary interest are the spin and parity of the resonance. States of four pions that observe Bose statistics and have zero isotopic spin divide into two symmetry types. The distributions are developed phenomenologically from the simplest possible T-matrix for each parity and symmetry type for spins zero and one. In general, eight variables characterize the four-particle decay problem. To facilitate the experimental determination of the spin, parity, and symmetry type, partial integrations of the distributions are performed analytically. The remaining variables are the two two-particle invariant masses of the Goldhaber triangle and angles. One of the angles orients the plane of two of the pions with respect to that of the other two. The distribution in this angle alone provides a significant partial identification of the quantum numbers of the resonance. For spin one, two more angles which specify an external direction were retained. In the reaction $p + \bar{p} \rightarrow 2\pi^+2\pi^- + \pi^0$ the resonance plus pion system was observed to be preferentially aligned with the beam direction. If production takes place equally from the four initial spin states, and if the spin of the resonance is not zero, then conservation of angular momentum along the beam direction results in anisotropy in the decay products. When available, this anisotropy is more sensitive to the spin, parity, and symmetry type than the angle between the planes is by itself. Author (NSA)

N68-19181 Yale Univ., New Haven, Conn.
COULOMB EXCITATION OF COLLECTIVE NUCLEAR STATES IN EVEN–EVEN NEODYMIUM AND GADOLINIUM NUCLEI
Gary Alfred Burginyon (Ph.D. Thesis) 1967 209 p
Available from Univ. Microfilms: HC $9.45/MF $3.00 Order No. 67-7000

Collective states in neodymium 142, 144, 146, 148, 150, gadolinium 154, and 158 were populated through Coulomb excitation with oxygen ions ranging from 42 to 72 MeV. The de-excitation gamma radiation from thick metal targets was detected singly, in coincidence with back-scattered oxygen ions, and in some cases in coincidence with other cascading gamma rays. New states have been found in Nd^{148} and Nd^{150}, and a number of previously unmeasured reduced transition probabilities are presented. The data are compared to predictions of the various phenomenological collective models. An attempt is made to account for deviations in the ground state band level spacings from the $I(I+1)$ rule of the axially symmetric rotor model by a first order perturbation treatment of band mixing with the beta and gamma bands. These results suggest the possibility of contributions from other mechanisms which is discussed, or the need for a more exact treatment of band mixing. Dissert. Abstr.

N68-19182 Texas Univ., Austin.
ISOBARIC ANALOGUE STATES OBSERVED IN I^{125}, I^{127}, I^{129} AND I^{131}
James Lee Foster, Jr. (Ph.D. Thesis) 1967 84 p
Available from Univ. Microfilms: HC $4.40/MF $3.00 Order No. 67-8103

Isobaric analogue states have been observed in proton elastic scattering from targets of Te^{130}, Te^{128}, Te^{126}, and Te^{124}. Comparison has been made with the corresponding levels observed in (d,p) reactions. Resonance parameters, spectroscopic factors and coulomb energies have been extracted. An optical model contribution has been added to the usual single level plus coulomb scattering formalism in the data analysis. Dissert. Abstr.

N68-19193 California Inst. of Tech., Pasadena.
THE MEASUREMENT OF STATIC ELECTRIC QUADRUPOLE MOMENTS OF EXCITED NUCLEAR STATES BY COULOMB EXCITATION
Robert Grandin Stokstad (Ph.D. Thesis) 1967 137 p
Available from Univ. Microfilms: HC $6.60/MF $3.00 Order No. 67-6981

Measurements of the probabilities for Coulomb excitation of the first 2^+ excited states in ^{114}Cd, ^{116}Cd, ^{126}Te and ^{128}Te have been made with ^4He, ^{12}C and ^{16}O ions. The deviations observed in a comparison of the experimental data with the predictions of first order perturbation theory are interpreted in terms of the static electric quadrupole moments, Q_2, of the first 2^+ excited states of the nuclei. The deduced values of Q_2 are found to lie in the ranges $-0.44 \geq Q_2 \geq -0.97$, $-0.67 \geq Q_2 \geq -1.18$, $-0.16 \geq Q_2 \geq -0.50$ and $-0.01 \geq Q_2 \geq -0.40$ $e \cdot 10^{-24}$ cm^2 for ^{114}Cd, ^{116}Cd, ^{126}Te and ^{128}Te, respectively. The deduced values of Q_2 for ^{114}Cd and ^{116}Cd are found to be surprisingly large when compared with the predictions of the vibrational model. Dissert. Abstr.

N68-19211# Australian National Univ., Canberra. Dept. of Nuclear Physics.
NUCLEAR REACTION THEORY AND ISOBARIC ANALOGUE STATES
D. C. Kean and S. N. Tucker 9 Nov. 1967 115 p refs
(ANU-P/393)

The basic scattering theory of Lippman and Schwinger are reviewed followed by a discussion of the various approaches to deuteron stripping, including the two potential formula for stripping, the distorted wave Born approximation, and Butler's three body approach. The isobaric analog states and the theory of isobaric analog resonances are considered. Finally, some of the approaches to the problem of describing nuclear reactions based on the analytical continuation of shell models into the continuum are discussed. R.N.A.

N68-19215 Oklahoma Univ., Norman.
ELECTROMAGNETIC INTERACTIONS OF 16.2 BEV NEGATIVE PIONS
Robert Lee Kinzer (Ph.D. Thesis) 1967 155 p
Available from Univ. Microfilms: HC $7.20/MF $3.00 Order No. 67-7331

A nuclear emulsion investigation of electromagnetic interactions of 16.2 BeV negative pions is performed. The emulsion stack is part of the Berkeley stack exposed at CERN. A study is made of the processes of pion–electron scattering (knock-on electron process) and of the direct production of high-energy electron–positron pairs by pions. Data collected is obtained using along-the-track scanning at a scanning rate of ≈ 23 cm./hr. 903 m. of track is examined. Dissert. Abstr.

N68-19230 Stanford Univ., Calif.
THE DERIVATIVE METHOD IN MANY BODY THEORY
John Harmen Marburger, III (Ph.D. Thesis) 1967 142 p
Available from Univ. Microfilms: HC $6.80/MF $3.00 Order No. 67-7946

The normal ordering techniques of Louisell, Walker and Heffner, previously restricted to systems described by hamiltonians at most quadratic in boson creation and annihilation operators, are here extended to the case of anticommuting operators and

self-interacting systems. These techniques are closely related to the method of functional derivatives in quantum field theory, and the term "derivative method" is used here to emphasize this connection. This method is used to compute approximate expressions in normal form for the second quantized time evolution and density operators for systems of interacting particles. Extension of the method to anticommuting variables is accomplished by specializing the "anticommuting c-number" formalism of the functional derivative method and treating the derivatives so obtained in the same way as those appearing in boson normal ordering prescriptions. Dissert. Abstr.

N68-19231 Texas Univ., Austin.
ANGULAR CORRELATION OF TWO-PHOTON POSITRON ANNIHILATION RADIATION IN LIQUID AND SOLID AMMONIA
William Henry Holt (Ph.D. Thesis) 1967 103 p
Available from Univ. Microfilms: HC $5.20/MF $3.00 Order No. 67-8114

Angular distributions of two-photon annihilation radiation have been measured in liquid (−56°C) and solid (−84°C) ammonia. The apparatus was of the annular-slit type and the angular resolution widths were approximately two milliradians. The coincidence resolving time was 77×10^{-9}sec. A thin window in the all-glass sample container allowed positrons from an external Na^{22} source to enter the ammonia samples. The data were corrected for accidental counts. Within the 2% statistical uncertainty of the data, the measured angular distributions were the same for both the liquid and solid samples. A linear average of the two distributions was taken to be the representative ammonia distribution. Geometrical resolution functions for the apparatus were calculated and an iterative procedure was used to correct the data for angular resolution. Assuming the density of momentum states to be spherically symmetric, the momentum distribution for the annihilating positron–electron pairs was determined from the corrected data. Dissert. Abstr.

N68-19244 Yale Univ., New Haven, Conn.
HYDROGEN BUBBLE CHAMBER STUDY OF K_L DECAYS AND K_S REGENERATION
Alexander Firestone (Ph.D. Thesis) 1967 129 p
Available from Univ. Microfilms: HC $6.20/MF $3.00 Order No. 67-7012

We have exposed the 80-inch liquid hydrogen bubble chamber to a beam of neutral K mesons produced from a 7 BeV/c π^- beam striking an aluminum target at the Brookhaven AGS. The distance from the target to the center of the bubble chamber was 31 feet. Approximately five K mesons were incident in the chamber per pulse, and about 190,000 exposures were taken of which about 2/3 have been analysed. The shape of the incident momentum spectrum is determined from a sample of $K_L \rightarrow \pi^+\pi^-\pi^0$ decays in which both γ-rays from the decay of the π^0 produced showers in a 1.5 radiation length tantalum plate. We present data on the differential and total cross sections for the reaction, $K_LP \rightarrow K_SP$, which indicate a negligible real part of the forward scattering amplitude above 2 BeV/c. Dissert. Abstr.

N68-19261# Atomics International, Canoga Park, Calif.
NEUTRON CROSS SECTIONS FOR PLUTONIUM 238, PLUTONIUM 242, AND CURIUM 244
C. L. Dunford and H. Alter 1 May 1967 142 p refs
(Contract AT(04-3)-701)
(NAA-SR-12271) CFSTI: HC $3.00/MF $0.65

Evaluated neutron cross section data for the nuclides ^{238}Pu, ^{242}Pu, and ^{244}Cm were prepared for ENDF/B. Because of the lack of experimental data, much of the information contained in these libraries is based on theoretical calculations. All experimental data available through December 31, 1966 was included in the evaluation. A complete set of neutron cross section data was prepared for each nuclide for incident neutron energies between 10^{-3} and 1.5×10^7 eV. These data in the ENDF/B format are available from the Cross Section Evaluation Center at Brookhaven National Laboratory. Author (NSA)

N68-19262# Stanford Univ., Calif. Stanford Linear Accelerator Center.
PHOTOPRODUCTION KINEMATICS TABLES FROM 0.5 TO 45 GEV
W. Busza, R. Diebold, and S. Ecklund Oct. 1967 196 p
(Contract AT(04-3)-515)
(SLAC-77) CFSTI: HC $3.00/MF $0.65

Kinematic quantities for two-body and quasi two-body photoproduction on protons are listed. Although the laboratory angle and momentum are given for both outgoing particles, differential quantities such as the solid angle transformation, Jacobians, etc., are given only for the long-lived charged particles (π^+, K^+, p); to this extent the tables are oriented toward spectrometer experiments. Each table is characterized by the laboratory photon energy and lists the various kinematic quantities every 5° in the cms from 0 to 180°. NSA

N68-19263# Sandia Corp., Albuquerque, N. Mex.
APPLICATION OF THE METHOD OF DISCRETE ORDINATES TO PHOTON TRANSPORT CALCULATIONS
James H. Renken and Kenneth G. Adams Jun. 1967 91 p refs
(Contract AT(29-1)-789)
(SC-RR-67-419) CFSTI: HC $3.00/MF $0.65

A useful method for performing photon transport calculations is the method of discrete ordinates. For one-dimensional problems the formalism of this method is implemented by a computer program called DTF. This program was originally written at Los Alamos for the solution of neutron transport problems. The original version of DTF has been modified to allow practical photon transport problems to be solved conveniently. Modifications include provision for external photon sources and the capability to treat fluorescence radiation. Presented here is the information necessary to use DTF for the solution of photon transport problems. Author (NSA)

N68-19277 Virginia Polytechnic Inst., Blacksburg.
DIRECT AND ABSOLUTE MEASUREMENTS OF AVERAGE YIELD OF NEUTRONS IN THERMAL FISSION OF U^{235} AND SPONTANEOUS FISSION OF Cf^{252}
Alexander De Volpi (Ph.D. Thesis) 1967 103 p
Available from Univ. Microfilms: HC $5.20/MF $3.00

Absolute measurements, using the manganese bath technique and prompt-neutron coincidence calibration of fission counters, have been carried out to obtain independent evaluations of the total yield of neutrons in thermal fission of $U^{235}[\bar{\nu}(U^{235})]$ and spontaneous fission of $Cf^{252}[\bar{\nu}(Cf^{252})]$. In this experiment, the neutron-fission coincidence phase was used to calibrate only the fission counter efficiency; this calibrated fission counter was then inserted in a large manganese bath where the fission rate and neutron rate were simultaneously monitored. The absolute efficiency of the manganese bath was determined with the aid of a series of supplementary experiments, including frequent comparison of absolute 4π beta–gamma coincidence counting with the liquid radio-assay system. The over-all neutron-detection efficiency relies heavily on the published manganese/hydrogen cross-section ratio, now known to about 0.3%. Dissert. Abstr.

N68-19285# Argonne National Lab., Ill.
CANDID-1D, A ONE-DIMENSIONAL, MULTIGROUP DIFFUSION-THEORY PROGRAM FOR THE CDC-3600
J. L. Zeman, H. Greenspan, and M. K. Butler May 1967 42 p refs
(Contract W-31-109-ENG-38)
(ANL-7319) CFSTI: HC $3.00/MF $0.65

The computer program CANDID-1D, which is written in FORTRAN 63 for the CDC 3600, is described. The program can be used to solve one-dimensional problems in plane, cylindrical, and spherical geometries. The real or adjoint solution can be calculated, and homogeneous (eigenvalue) or inhomogeneous (external source) problems can be solved. Three criticality search options are provided in addition to the flux-convergence, or k_{eff} calculation. NSA

N68-19289 Vanderbilt Univ., Nashville, Tenn.
NUCLEAR SHELL MODEL STUDIES IN THE MASS REGION NEAR A = 88
Robert Michael Tarbutton (Ph.D. Thesis) 1967 99 p
Available from Univ. Microfilms: HC $5.00/MF $3.00 Order No. 67-7466

Hughes, Snow, and Pinkston have made least squares fits of the strength parameters of a T = 1 central-plus-tensor interaction for nuclei treated as two particles outside a closed shell. They found a potential which fits well both ^{18}O and ^{210}Po and which has some of the properties of the free two-nucleon potential; however, their treatment of ^{86}Sr and ^{90}Zr using a ^{88}Sr core gave a rather poor fit and an interaction which is rather unrealistic. Assuming that ^{88}Sr is not a good core, we have treated several nuclei as consisting of a core of 50 neutrons and 28 protons, with protons in the $1f_{5/2}$, $2p_{3/2}$, $2p_{1/2}$, and $1g_{9/2}$ shells interacting through the ^{18}O–^{210}Po potential. These calculations, including as many as four $g_{9/2}$ particles, were performed using a shell-model program written for the IBM-7090 computer. Starting with an estimate based on first order perturbation theory, the single particle energies were varied to give a good fit to the known energy levels of ^{87}Rb, ^{88}Sr, ^{89}Y, and ^{90}Zr. A few spectroscopic factors were also calculated which gave relatively poor agreement with experiment. Dissert. Abstr.

N68-19292 Stanford Univ., Calif.
THE INTERACTION OF FAST NEUTRONS WITH ORIENTED Ho^{165} NUCLEI
Edward George Shelley (Ph.D. Thesis) 1967 203 p
Available from Univ. Microfilms: HC $9.25/MF $3.00 Order No. 67-7970

The interactions of polarized and unpolarized neutrons with oriented and unoriented Ho^{165} nuclei were investigated. A one mole sample of polycrystalline holmium metal with a neutron transmission 0.175 and 0.160 at 8 and 15 MeV, respectively, was cooled to 0.34°K and magnetized to $M/M_\infty = 0.70$ parallel to the neutron beam. The first four "statistical" tensors were $B_1 = 0.55$ B_1 max; $B_2 = 0.25$ B_2 max; $B_3 = 0.06$ B_3 max; and $B_4 = 0.02$ B_4 max. The "deformation effect," $\Delta\sigma_{Def} = \sigma$(oriented)–$\sigma$(unoriented), was measured for unpolarized neutrons of 8 MeV and 15 MeV using the $Be^9(\alpha,n)C^{12}$ and $H^3(d,n)He^4$ reactions. $\Delta\sigma_{Def}$(8 MeV) = −38±10 mb and $\Delta\sigma_{Def}$(15 MeV) = −140±16 mb. The "spin–spin effect," $\Delta\sigma_{ss} = \sigma_{\uparrow\uparrow} - \sigma_{\uparrow\downarrow}$ where $\sigma_{\uparrow\uparrow}$ and $\sigma_{\uparrow\downarrow}$ are the total cross sections for neutron and nuclear spins parallel and antiparallel, respectively, was measured at $E_n = 7.85$ MeV using the polarized neutrons from the $Be^9(\alpha,n)C^{12}$ reaction at $\theta_{Lab} = 45°$ ($P_n = 0.34$); $\Delta\sigma_{ss}$(7.85 MeV) = +3±13 mb. Dissert. Abstr.

N68-19300# Oak Ridge National Lab., Tenn. Neutron Physics Div.
CSP-I: A NEUTRON CROSS SECTION AVERAGING PACKAGE FOR USE WITH THE 05R DATA TAPE
K. J. Yost and N. M. Greene Dec. 1967 111 p refs
(Contract W-7405-ENG-26)
(ORNL-4130)

A code package, identified as CSP-I, was developed for averaging cross-section data to be used as input to the S_n radiation transport codes. The code, designed to work from the 05R data tape, allows up to 200 energy groups with arbitrary boundaries and can accommodate up to a P_{10} approximation to elastic-scattering distributions. Author (NSA)

N68-19304# Polish Academy of Sciences, Cracow. Inst. of Nuclear Physics.
THE CALCULATIONS AN ANGLE FROM THE LAB SYSTEM FOR AN ANGLE IN THE CM SYSTEM AND THE CONTRARY CALCULATIONS. THE PROGRAMS FOR THE COMPUTER UMC-1 WITH THE FUNDAMENTAL PROGRAM K-1 [PRZELICZENIE KATA Z UKLADU LABORATORYJNEGO NA KAT W UKLADZIE CENTRUM MAS ORAZ PRZELICZENIE ODWROTNE. PROGRAMY DLY MASZYNY CYFROWEJ UMC-1 PRZY PROGRAMIE PODSTAWOWYM K-1]
Stanislawa Jelonek 1967 27 p In POLISH; ENGLISH summary
(Rept.-564/PL)

The first program calculates an angle from the laboratory system and converts it into an angle from the center of mass system. The second program does the same, and in addition, calculates $\sin^4 0.5\,\theta_{cm}$. The third program converts an angle from the center of mass system into one for the laboratory system. Transl. by E.J.S.

N68-19306 North Carolina State Coll., Raleigh.
SOME ASPECTS OF NEUTRON TRANSPORT THEORY UNIFICATION
Amos Gentry Bullard, Jr. (Ph.D. Thesis) 1967 217 p
Available from Univ. Microfilms: HC $9.90/MF $3.00 Order No. 67-7411

This research examines a framework wherein the traditional transport approximations may be derived in a uniform and consistent manner, the new aspects of thermalization can be examined, and the structural relationships between slowing and thermalization can be viewed. A by-product of such a unifying system is the identification and evaluation of all assumptions associated with mathematical approximations to the transport equation and the generation of new forms worthy of additional attention. A demonstration of another unification concept is given by the study of the role of Green's functions in the solution of the infinite medium slowing and thermalization problems. The origin of Green's function applications to the solution of the integral equation describing neutron slowing through resonances is cited. The extension of this approach to include its use in the determination of resonance absorption and upscattering effects on thermal neutron spectra is presented. Dissert. Abstr.

N68-19312 California Inst. of Tech., Pasadena.
NEUTRAL MESON PHOTOPRODUCTION FROM HYDROGEN AT FORWARD ANGLES IN THE PHOTON ENERGY RANGE, 750–1500 MeV
George Laurie Hatch (Ph.D. Thesis) 1967 109 p
Available from Univ. Microfilms: HC $5.40/MF $3.00 Order No. 67-8978

Measurements have been made of the cross-sections for neutral meson photoproduction from protons at angles in the forward hemisphere for photon energies near 911, 1182, and 1390 MeV. The experimental method consists of detecting the decay gamma-rays of the neutral meson in two pb-glass total absorption Cerenkov counters. The results agree very well with the existing

data where the same points have been measured. The striking feature of the angular distributions at 1182 and 1390 MeV is the small 0° cross-section and peak near 30° to 40° in the CMS. Using as a model for the cross-section calculation a vector meson X° exchange plus background, we find the product $\Gamma(X^\circ \rightarrow \pi^\circ + \gamma) \times \gamma^2 XNN/4\pi \simeq 1.8 \pm 0.2$ MeV for $M_X = 788$ MeV. Fits made without the vector meson pole are not inconsistent with a resonance model for the cross-section. Dissert. Abstr.

N68-19319# Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires.

EXPERIMENTAL STUDY OF THE THERMAL FISSION OF ^{235}U IN THE REGION OF SYMMETRICAL MASSES [CONTRIBUTION A L'ETUDE EXPERIMENTALE DE LA FISSION THERMIQUE DE L'URANIUM 235 DANS LA REGION DES MASSES SYMETRIQUES]

Michel Ribrag (Ph.D. Thesis—Paris Univ.) 17 Mar. 1967 82 p refs In FRENCH
(CEA-R-3309)

Energy correlation experiments with fission fragments are strongly perturbed, in the symmetric region, by the detection of spurious events caused by the apparatus. It is shown that the measurement of an additional parameter, namely the difference in time-of-flight between the fragments enables one to eliminate these difficulties. An original method of calibration of the time-of-flight set-up is also shown. For thermal fission of ^{235}U, values of mass yields in the symmetric region are found to agree quantitatively with radiochemical values. Moreover, the average total kinetic energy distribution as a function of the pre-neutron-emission masses of the fragments has been calculated. This curve presents in the symmetric region a large dip, the value of which takes on the value 21.2±0.8 MeV. This value is smaller than previously published results. Author (NSA)

N68-19324# Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik.

SOME NEW MEASUREMENTS AND RENORMALIZATIONS OF NEUTRON CAPTURE CROSS SECTION DATA IN THE KEV ENERGY RANGE

W. P. Poenitz, D. Kompe, H. O. Menlove, and K. H. Beckurts Oct. 1967 15 p refs Presented at the Symp. on Fast Reactor Phys. and Related Safety Probl., Karlsruhe, Ger., 30 Oct.–3 Nov. 1967
(KFK-635; SM-101/9; EUR-3679.E)

Details are given on the experimental technique used to measure the absolute capture cross section of gold between 25 and 500 keV to an accuracy of about ±5%. It is proposed to use this cross section curve as a standard for further renormalizations of capture and fission cross sections. Although the method of determining the gold cross section is conceded to be tedious and time-consuming, it is believed that some cross sections like U^{238} capture and U^{235} fission are so fundamental to fast reactor calculations that they warrant a direct determination by essentially the same method in order to avoid additional errors due to a cross section ratio measurement. Figures depict the gold capture cross section and the U^{238} capture cross section as functions of neutron energy. Experimental values of U^{238} capture cross section are compared with compiled values, and capture cross section data are plotted for Nb, Hf, Mo, Ta, Cs, W, and Re. The implications of these data on reactor calculations are assessed. M.G.J.

N68-19358*# Volt Technical Corp., Washington, D. C.

ON THE UPPER LIMIT OF ANTINUCLEI CONTENT IN COSMIC RAYS

N. S. Ivanova, Yu. F. Gagarin, and V. N. Kulikov 18 Mar. 1968 7 p refs Transl. into ENGLISH from Kosmich. Issled. (Moscow), v. 6, no. 1, 1968 p 83–87
(Contract NAS5-12487)
*(NASA-CR-93476; ST-CR-NP-10688) CFSTI: HC $3.00/MF $0.65 CSCL 20H

The upper limit of the number of antinuclei in the content of cosmic rays is estimated on the basis of the study of nuclear emulsions exposed at 300 km, and of the investigation of all multi-charge particles at rest in the emulsion and of all interactions induced by them. When determining the upper limit of the number of antinuclei, account was taken of the corrections of the difference in the interaction cross-sections of nuclei and antinuclei in the emulsion and for the secondary origin of a certain part of stopping multi-charged particles. A value $n\bar{A} < 0.59\%$ is obtained for the upper limit of the multi-charge component of primary cosmic rays. Author

N68-19375# Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.

SOME FEATURES OF NEUTRAL PION PRODUCTION IN INTERACTIONS OF 9 GEV NEGATIVE PIONS WITH XENON NUCLEI [NIEKTORE WLASNOSCI PRODUKCJI NEUTRALNYCH PIONOW W ZDERZENIACH UJEMNYCH MEZONOW PION O ENERGII 9 GEV ZJADRAMI KSENONU]

T. Siemiarczuk 1967 17 p refs
(INR-844/6/PH) CFSTI: HC $3.00/MF $0.65

The energy and angle of emission of 3271 photons emitted in 1374 π-Xe interactions at 9 GeV have been measured and the process leading to π° production is discussed. Author

N68-19386*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

ELASTIC SCATTERING OF SLOW ELECTRONS BY TWO-ELECTRON IONS

M. R. C. McDowell Feb. 1968 29 p refs
(NASA-TM-X-63137; X-641-68-60) CFSTI: HC $3.00/MF $0.65 CSCL 20H

A one channel model, previously used for He, is extended to allow calculation of elastic scattering by H^- and Li^+ at energies up to three rydbergs. Nonseparable ground state wave functions are used, allowance being made for exchange, and dipole and quadrupole polarization potentials. Results for Li^+ are in good agreement with quantum defect method values. Calculated differential cross sections for elastic scattering by H^- at energies of one half and one rydberg are presented. Deviations from Couloumb scattering are marked. Author

N68-19436*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

ELECTRON IMPACT IONIZATION OH H(2S) AND H(2P)

H. Lee Kyle and K. Omidvar Mar. 1968 35 p refs
(NASA-TM-X-63143, X-641-68-90) CFSTI: HC $3.00/MF $0.65 CSCL 20H

Cross sections for the ionization of the first excited levels of atomic hydrogen have been calculated using two quite different theories: The Born exchange approximation and the Vainshtein binary collision approximation. In the Born exchange calculation Prasad's (2s → c) cross sections are confirmed and it is found that positive interference occurs for (2pm = ± 1 → c) cross sections in the Born exchange (i) approximation. The binary collision approximation would appear to yield rather poor results in this case. This theory is formulated in some detail and the approximations made carefully pointed out. Author

N68-19444# Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires.

ANALYTICITY PROPERTIES OF TWO BODY HELICITY AMPLITUDES [PROPRIETES D ANALYTICITE DES AMPLITUDES D HELICITE A DEUX CORPS]

Henri Navelet-Noualhier (Ph.D. Thesis—Paris Univ.) 1967 135 p refs In FRENCH
(CEA-R-3303)

Helicity amplitudes are expressed via the spinor amplitudes in terms of the Joos invariant which were shown by Williams to be free from kinematical singularities. This procedure allows one to analyze the kinematical singularities of helicity amplitudes and separate them out, which results in the definition of regularized helicity amplitudes. A crossing matrix for helicity amplitudes is written down, corresponding to the continuation path used to cross spinor amplitudes. It is explicitly verified that the corresponding crossing matrix for regularized helicity amplitudes is uniform as it should be. Kinematical constraints which generalize, to the case of arbitrary spins and masses, relations which must hold between helicity amplitudes at some values of the energy variable in $\pi N \rightarrow \pi N$, $\pi\pi \rightarrow N\bar{N}$ and $N\bar{N} \rightarrow N\bar{N}$ reactions, appear as a consequence. Author (NSA)

N68-19471 University of Southern Calif., Los Angeles.
APPLICATION OF THE METHOD OF STATIONARY PHASE TO POTENTIAL SCATTERING THEORY
Donald Henry Albert Hageman (Ph.D. Thesis) 1967 181 p refs
Available from Univ. Microfilms: HC $8.40/MF $3.00 Order No. 67-6499

The scattering of a spinless particle by a time-independent potential $V(\vec{r})$ is treated by applying the method of stationary phase first to Feynman's path integral representation of the amplitude or kernel $K(\vec{r}_b, t_b; \vec{r}_a, t_a)$, thus obtaining an approximate kernel $\bar{K}$, then to the corresponding approximate Green's function $\bar{G}(\vec{r}_b, \vec{r}_a, E_0)$, which is defined to be the projection out of $\bar{K}$ of the Fourier component associated with the energy E_0. An approximation to the scattering amplitude is determined directly from $\bar{G}$. The approximation method is applied first to the one-dimensional centrifugal potential, a case for which all desired calculations can be performed explicitly. The second application of the approximation method is to the Coulomb potential. The third application of the approximation method is to a general spherically-symmetric potential which is sufficiently smooth. Dissert. Abstr.

N68-19472 Arizona Univ., Phoenix.
FILTRATION OF CHARGED PARTICLES IN AN ELECTRICAL FIELD
Frederick Christian Cooper (Ph.D. Thesis) 1967 103 p
Available from Univ. Microfilms: HC $5.20/MF $3.00 Order No. 67-6829

Continuing studies on forced-flow electrophoresis and its applications in water treatment have shown that a uniform direct current electrical field imposed across a membrane filter improves the filtration rate when there is an anionic movement of charged particles countercurrent to the hydraulic flow. This phenomenon, termed electrofiltration, is a combination of simple filtration, electroosmosis, and electrophoresis. A mathematical model is presented based on a modification of the conventional Kozeny–Carman filtration equation. The parameters of applied voltage gradient, filtration pressure, solids loading, sludge removal and type of filter media are investigated as to their respective roles in the process. The study is limited to constant-pressure filtration employing slurries of colloidal clays of larger diameter than the pores of the filter media. Dissert. Abstr.

N68-19479# Joint Inst. for Lab. Astrophysics, Boulder, Colo.
PHOTODISSOCIATION OF H_2^+ AND D_2^+: THEORY AND TABLES
Gordon H. Dunn 30 Jan. 1968 57 p refs Supported in part by AEC
(JILA-92)

Theory is described and tables of results presented of photo-dissociation cross sections of H_2^+ (D_2^+) from each of the ion's 19 (27) vibrational levels. Cross sections are summed over an assumed Franck–Condon distribution of initial vibrational states to give a predicted cross section for comparison with experiment. Author

25 PHYSICS, PLASMA

Includes magnetohydrodynamics. For applications see: 28 Propulsion Systems.

N68-18284# Innsbruck Univ. (Austria). Inst. for Theoretical Physics.
NUCLEAR EXPLOSIONS IN AN IONOSPHERE WITH FINITE ELECTRIC CONDUCTIVITY IN THE PRESENCE OF A UNIFORM MAGNETIC FIELD
Ferdinand Cap and Norton Rimer (City Coll. of the City of N. Y.) 5 Nov. 1967 36 p
(Contract F61052-67-C-0014)
(SR-52; AFOSR-68-0148; AD-664034) CFSTI: HC $3.00/MF $0.65

In the following report the problem of a nuclear explosion in the ionosphere approximated by an expanding spherical bubble has been investigated. Based on the assumption of finite electric conductivity, there are two regions of interest, the plasma and the expanding bubble. Finite electric conductivity changes the system of equations from a purely hyperbolic to a mixed system. For this two-dimensional unsteady flow problem, the method of characteristics is far more difficult, since the characteristics are surfaces instead of curves. A numerical method involving a three-dimensional grid has been developed. Author (TAB)

N68-18322# Aerospace Corp., El Segundo, Calif. Aerodynamics and Propulsion Research Lab.
HIGH FREQUENCY BREAKDOWN OF NONUNIFORM GASES IN SPATIALLY VARYING FIELDS, AUGUST–SEPTEMBER 1967
Melvin Epstein Nov. 1967 27 p refs
(Contract F04695-67-C-0158)
(TR-0158(3240-20)-5; SAMSO-TR-67-116; AD-664053) CFSTI: HC $3.00/MF $0.65

A method is described for predicting the field strength required to produce cw breakdown of gases with spatially varying properties subjected to electric fields of nonuniform intensity. The proposed method is based on a variational principle derived from the electron continuity equation. A Ritz method is used to generate solutions of the variational problem. The approximate solutions are evaluated by comparing them with several exact solutions which are also developed in this paper. The use of a one-term trial function in the Ritz method is found to give very good agreement with the exact solutions. A two-term approximation provides greater accuracy than is presently available from experimental data. Author (TAB)

N68-18335# Stevens Inst. of Tech., Hoboken, N. J. Dept. of Physics.
STUDY OF STABILITY OF HYDROMAGNETIC PLASMAS AND THEORETICAL AND EXPERIMENTAL INVESTIGATION OF THE BEHAVIOR OF IONIZED GASES IN A MAGNETIC FIELD UNDER SHOCK CONDITIONS Final Scientific Report, 1 Jun. 1963–31 May 1967

A. Besse, W. H. Bostick, A. Deshmukh, G. Emmert, E. Farber et al. Dec. 1967 56 p refs
(Contract AF 19(628)-2398)
(SIT-P207(12/67); AFCRL-67-0675; AD-664342)

Driver temperatures in excess of 25,000K were attained for an arc driven shock tube by utilizing a prestressed ceramic liner. Contamination and cooling of the driver gas by evaporated liner products were reduced. A laser interferometer was perfected for the study of strong ionizing shocks. Measurements on argon shocks allow detection of the passage of the shock front, determination of the length of the ionized gas sample and determination of the electron density in the ionized gas. Another diagnostic technique employed in the study of the ionized gas sample utilizes an electron beam. Electron scattering and spectroscopic analysis of the radiation permit determination of particle density and rotational and vibrational temperatures in the ionized gas. Plasma-magnetic field interfaces are studied in several geometries. Studies were performed on trajectories of parallel-to-B sub o plasma vortices which travel in a magnetic field with a gradient. A plasma camera was developed for this type of vortex in a homogeneous magnetic field and data indicate the plasma vortex structure to be very complex. Schlieren instrumentation for perpendicular-to-B sub o was constructed to be used on a parallel plate accelerator. Author (TAB)

N68-18337# Army Dept., Washington, D. C.
[INTERACTION OF THE GLOW FRONT WITH A TRANSVERSE MAGNETIC FIELD IN AN ELECTRODYNAMIC SHOCK TUBE [VZAIMODEYSTVIYE FRONTA SVECHENIYA V ELEKTRODINAMICHESKOY UDARNOY TRUBKE S PROPERECHNYM MAGNITNYM POLEM]
G. I. Goryaga, A. I. Kokorev, and N. M. Persiyantseva 26 Oct. 1967 11 p refs Transl. into ENGLISH from Herald of the Moscow State Univ., no. 4, Jul.–Aug. 1966 p 3–8
(NIC-TRANS-2482; AD-664436)

An investigation was performed into the nature of the glow front in an electrodynamic shock tube. Experiments performed on the interaction of the glow front with a transverse magnetic field showed that the glow front corresponds to the leading edge of the plasma ejected from the discharge chamber. The shock wave front becomes visible only after interacting with an obstacle.
Author (TAB)

N68-18390# Army Missile Command, Huntsville, Ala. Physical Sciences Lab.
GUIDING OF SELF-FOCUSED RELATIVISTIC ELECTRON BEAMS
Thomas G. Roberts 31 Oct. 1967 64 p refs
(RR-TR-67-16; AD-664135)

The magnetic field of a conventional linear pinched argon plasma was used to guide a self-focused intense beam of relativistic electrons. A 30-nsec, 30,000-amp pulse of 3.5 MeV electrons was extracted from the electrode space of a flash X-ray machine and injected into the end of a cylindrical plasma column. The plasma column contained a 90-deg bend on a radius of 15 cm and the high energy electron beam was guided around this curve without becoming defocused and without causing the plasma column to become unstable. Author (TAB)

N68-18401# Sperry Rand Research Center, Sudbury, Mass.
AN EXPERIMENTAL AND THEORETICAL STUDY OF THE NON-EQUILIBRIUM PLASMA IN THERMIONIC DISCHARGES Final Report, 1 Dec. 1966–30 Nov. 1967
Ronald H. Curry, David W. Norcross, Philip M. Stone, Kaare J. Nygaard Jan. 1968 66 p refs
(Contract Nonr-5154(00))
(SRRC-CR-68-4; AD-664494) CFSTI: HC $3.00/MF $0.65

Effective coefficients for ionization and radiative energy loss were computed for different values of electron temperature and density. These coefficients and the neutral density yield the rates for net ion production and radiative energy loss from all sources except the resonance lines. Energy loss from resonance lines and the ion production cost are considered separately. The following general conclusions can be drawn: (1) the area within 0.4 mm of the emitter is a source of ion-electron pairs, the rest of the plasma being a sink; (2) inelastic energy losses decrease monotonically from the emitter to the collector; and (3) these effects are relatively independent of cesium pressure, but are generally proportional to output density. Furthermore, the differential equations governing the transport of particles, momentum, and energy in the plasma between the electrodes of a thermionic converter were more completely formulated. Specific advances are the inclusion of more exact coefficients for electron transport and for ion production and radiative energy loss in the plasma volume. In diode experiments, the electron temperature was determined from measurement of the continuum emitted by radiative recombination to the 6P states of cesium, and the electron density was determined from Stark broadening of the fundamental series lines. Of particular interest is observation of forbidden lines. Author (TAB)

N68-18407# Innsbruck Univ. (Austria). Inst. for Theoretical Physics.
A STUDY OF THE SOLUTIONS OF ONE-DIMENSIONAL VLASOV–POISSON EQUATIONS FOR HARMONIC TIME DEPENDENCE AND EXTERNAL POTENTIAL
Gottfried Tinhofer 30 Oct. 1967 17 p refs
(Contract F61052-67-C-0014)
(AFOSR-68-0226; SR-51; AD-664585)

The behavior of the solutions of a simplified form of the system of Vlasov-Poisson equations is studied. An external disturbance function is intended to simulate a confining magnetic field. A condition for the existence of continuously differentiable solutions is derived which has the form of an integral relation between the Poisson function and its derivative. The two cases of a given spatial distribution and a given velocity distribution are considered. Author (TAB)

N68-18441# California Univ., Los Angeles. Plasma Physics Group.
[JOINT EXPERIMENTAL AND THEORETICAL INVESTIGATIONS IN PLASMA PHYSICS] Final Report
A. Y. Wong Jul. 1967 7 p refs
(Grant AF-AFOSR-962-65)
(A2; AFOSR-68-0121; AD-664002)

The research involved studies with a Q-machine plasma. Specific topics of research are (1) collisional effects on electrostatic ion cyclotron waves and (2) cyclotron echo phenomena. TAB

N68-18485*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ENHANCEMENT OF ION CYCLOTRON WAVES IN HYDROGEN HELIUM MIXTURES
Henry J. Hettel, Roman Krawec, George M. Prok, and Clyde C. Swett Washington Mar. 1968 35 p refs
(NASA-TN-D-4271) CFSTI: HC $3.00/MF $0.65 CSCL 20I

The admixture of helium to a hydrogen plasma atmosphere has increased the radiofrequency power absorption in the ion-cyclotron mode. Measurements of power absorption, plasma radius, electron density, and magnetic flux density at the peak power point were obtained as a function of plasma composition. A relation was derived involving these experimental parameters and the ion density. It is shown that the observed power enhancement can be explained if it is assumed that the metastable states of the helium atoms react with hydrogen atoms and molecules to increase the plasma ion density. Author

N68-18515 Minnesota Univ., Minneapolis
A STUDY OF AN INDUCTIVELY COUPLED PLASMA
Donn Reynolds Armstrong (Ph.D. Thesis) 1966 94 p
Available from Univ. Microfilms: HC $4.80/MF $3.00 Order No. 67-8067

A design model based on energy balance considerations was developed for an induction-coupled plasma which can be used for high-temperature chemical reactions. The model accounts for three mechanisms of energy transfer, an induction energy input and two heat loss rates, one involving radiation and the other conduction and convection. To test the model an axial flow argon plasma with diameter of order 1 cm. was obtained in the frequency range from 15 to 30 MHz and at a peak power of 2 Kw. This plasma was used to determine an empirical constant in the model and test predictions of the model. Power was measured calorimetrically. Radiation was measured with an axial radiometer and R. F. current was measured using a toroidal sensing coil and hot-wire ammeter. The model predicted existence conditions and division of power between radiation and conduction-convection within ±20% of the powers for the argon plasma. Dissert. Abstr.

N68-18531# Los Alamos Scientific Lab., N. Mex.
CALCULATION OF HIGH BETA TOROIDAL PLASMA EQUILIBRIUM
Thomas A. Oliphant 16 Nov. 1967 10 p refs
(Contract W-7405-ENG-36)
(LA-3749) CFSTI: HC $3.00/MF $0.65

A numerical procedure is described for calculating a high-beta, thin-skinned, toroidal plasma equilibrium. The mathematical problem involved is the solution of Maxwell's equations with a boundary between a perfectly conducting plasma and the magnetic field. This boundary must take such a shape that the magnetic field-plasma pressure balance relation holds. The mathematical problem is formulated in detail and a numerical example is presented which possesses very reasonable geometric properties, and which has external fields similar to those contemplated for the Scyllac toroidal θ pinch. Author (NSA)

N68-18537 Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
EXPERIMENTAL STUDIES OF A COAXIAL PLASMA INJECTOR. 2: PROBE MEASUREMENTS OF ELECTRON TEMPERATURE [EKSPERYMENTALNE BADANIA KOAKSJALNEGO INIEKTORA PLAZMOWEGO. 2: POMIARY SONDOWE TEMPERATURY ELEKTRONOWEJ]
Marek Sadowski and Elzbieta Skladnik-Sadowska 1967 22 p refs Submitted for publication
(Rept.-851/18/PP)

In order to determine the conductivity and electron temperature of plasma generated by the coaxial injector, a detailed analysis of diamagnetic signals from plasmoids injected into a uniform magnetic field was performed. For purposes of comparison, a number of measurements were made by means of a double Langmuir probe for the case without the external magnetic field, and in the space beyond the diagnostic field. Author

N68-18562# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems.
INVESTIGATION OF IONIZATION OF H POLARIZED ATOMS IN THE PENNING DISCHARGE [ISSLEDOVANIE IONIZATSII POLYARIZOVANNYKH ATOMOV VODORODA V RAZRYADE PENNINGA]
Yu. A. Plis and L. M. Soroko 1967 8 p refs In RUSSIAN Submitted for publication
(JINR-P9-3589)

The results of investigation of polarized atoms ionization in an apparatus with the Penning discharge are given. The ionization efficiency turned out to be proportional to the anode length. At the anode length equal to 36 mm the ionization efficiency is equal to $(0.7\pm0.15)10^{-3}$, and at the length of 130 mm it is equal to $(2.7\pm0.6)10^{-3}$. The experimental results are compared with the data published. Author (NSA)

N68-18570# Princeton Univ., N. J.
EXCITATION OF THE FAST MAGNETOACOUSTIC WAVE IN THE STELLARATOR PLASMA
P. Ya. Burchenko, B. T. Vasilenko, E. D. Volkov, A. V. Longinov, R. M. Nikolaev et al [1967] 9 p refs Transl. into ENGLISH from Rept. FTI-289/P-103
(Contract AT(30-1)-1238)
(MATT-TRANS-43; FTI-289/P-103) CFSTI: HC $3.00/MF $0.65

Investigations were made on the excitation of fast magnetoacoustic waves in stellarator plasma in the frequency range of $\omega_{ce} > \omega > \omega_{ci}$ and $\Omega_e > \omega_{ce}$ (ω_{ce}, ω_{ci} are the cyclotron frequencies of the electrons and ions, Ω_e is the Langmuir electron frequency). NSA

N68-18572# Institut fur Plasmaphysik G.m.b.H., Garching (West Germany).
ANNUAL REPORT, 1965 [JAHRESBERICHT, 1965]
1965 146 p refs In GERMAN
(NP-16754)

The Institute for Plasma Physics consists of three experimental divisions—theoretical, technical, and auxiliary services. The most important study of the first division was connected with the heating and containment of plasmas by fast magnetic compression in the theta pinch. The most progress was made in the introduction of the ISAR installation which consists of a fast energy accumulator of maximum 2.6 MJ. Using preionization by fast collision current along the axis of the discharge vessel (z pinch) it is possible to ignite plasmas of relatively low density and relatively high purity. At an energy of 1.5 MJ, ion temperatures up to 5.3 keV were obtained. The containment time was 10^{-5} sec and was limited by the loss from the end of the 1.5-m-long discharge vessel. A relative long displacement of the compressed plasma from the tube axis was observed, but there were no visible instabilities. Special emphasis was placed on the development of methods for measurement of physical properties of these plasmas. The scattered light method gave the best results; pulsed ruby lasers with power up to several 100 MV were used as light sources. By introduction of a multigap of glass fibers a simultaneous measurement could be made of seven ranges of the scattered light spectrum. At the temperatures and densities and the scattering angle used, the plasma electron no longer acts as an individual scatter, but correlation effects between the electrons begin to appear. The second division concentrated on toroidal containment. The behavior of cesium plasma produced by contact ionization in an arrangement of the stellarator type and in an octupole torus, was studied. Studies have shown that the particles leave the space more rapidly than electrical conductivity calculations showed. The advantages of the alkali plasma produced by contact ionization were used in other studies in simple geometry to verify the plasma behavior and the plasma diagnostic methods. The properties of longitudinal plasma oscillation or Bernstein waves and that of the harmonics of the electron gyrofrequency were investigated. The possibilities and difficulties of the HELIOS project are intensively discussed. The work of the third division was concentrated on flowing stationary hydrogen plasmas of the arc type. Systematic measurements were made of the temperature, density, and velocity at the midpoint. Theoretical considerations were reported on the possibility of addition heating. The EIERUHR discharge group began with measurement of the potential distribution of the azimuthal current. The radial electron density distribution was determined by measurement of the Faraday rotation. Intensity measurements of the O V and O VI lines verified that the temperature maximum was over 200,000°.

Studies on nonstationary collision waves with an inteferometer and microwaves were completed; a detailed picture of the mechanism of this process is given. The work of the technical group with respect to high-voltage techniques, electronics, magnetic field technology, vacuum technology, and installation and construction is summarized. The publications of the Institute are compiled. NSA

N68-18814*# National Aeronautics and Space Administration. Electronics Research Center, Cambridge, Mass.

A STUDY OF THE POSSIBLE USES OF PLASMA FOR MILLIMETER WAVE GENERATION

Robert E. McIntosh Washington Mar. 1968 28 p refs

(NASA-TN-D-4309) CFSTI: HC $3.00/MF $0.65 CSCL 20I

The millimeter wave portion of the frequency spectrum has not been utilized in communication systems because of a lack of practical, high-power mm wave generators. As conventional tube design techniques have been only moderately successful in extending the microwave power frequency frontier, a number of novel approaches for obtaining mm wave sources have been suggested. Two of these methods rely on the use of a gaseous plasma and are described in this technical note. The electron beam-plasma interaction and the plasma multiplier have been investigated during the last decade in the hope that one or the other might have some application at mm wavelengths. So far the expectations for these devices have not been realized because of many unresolved engineering problems. This report describes the major difficulties that must be overcome before further development in this area can proceed, and it attempts to evaluate the potential of both devices. Author

N68-18725*# Pennsylvania State Univ., University Park.

A KINETIC THEORY BOUNDARY VALUE PROBLEM IN A FLOWING PLASMA: THE IMPEDANCE OF A GRID PAIR

D. P. Mioduszewski 1 Mar. 1968 103 p refs

(Grants NGR-39-009-032; NSF GP-5611)

(NASA-CR-93428; SR-316) CFSTI: HC $3.00/MF $0.65 CSCL 20I

A technique is developed for handling a class of plasma kinetic theory boundary value problems where plasma flows are taken account and then applying it to the problem of calculating the impedance of a grid pair through which a plasma is flowing perpendicularly to the grids. The Fourier–Laplace Transforms are used to solve the problem after the inclusion of the boundary values into the differential equations. Graphs of the impedance are obtained for various parameters. It is shown that the negative resistance, which Rydbeck showed could exist using the cold-electron fluid theory, is a drift phenomenon and does not exist for a stationary plasma. In addition, it is also shown that Debye shielding disappears when the drift velocity becomes much greater than the thermal velocity of the plasma and that Debye shielding is directly related to the fast wave of the cold electron fluid theory. Author

N68-18855 Australian National Univ., Canberra. Dept. of Engineering Physics.

ON THE EVALUATION OF ELASTIC AND INELASTIC COLLISION FREQUENCIES FOR HYDROGENIC-LIKE PLASMAS

E. L. Bydder Sep. 1967 76 p refs

(EP-RR-17)

Detailed calculations of the generalized collision frequencies for the principal elastic, excitation, ionization, and charge exchange collisions in the formation of a hydrogenic plasma are given. A modified form of Born's approximation is used for the differential cross sections, and approximations corresponding to a high temperature gas are used. The results enable certain sets of 13-moment equations describing the plasma formations to be completed. Author

N68-18899# United Kingdom Atomic Energy Authority, Culham (England). Research Group.

DESTRUCTION OF THE SHARP TRANSITION IN COLLISIONLESS SHOCK WAVES DUE TO HIGH β EFFECTS

A. Iiyoshi Aug. 1967 12 p refs

(CLM-R-74) HMSO: 1s 9d

In this paper the magnetosonic wave propagating almost perpendicular to the magnetic field is discussed in connection with the destruction of a sharp shock transition at high Alfven Mach number ($M_A > 3$) observed in collisionless shock experiments. It is proposed that at a critical Alfven Mach number ($M_A = 3 \approx 4$) the values of β and the local magnetosonic Mach number behind the shock become nearly unity. These effects would allow the waves to propagate upstream forming another quasi-shock wave whose dissipative mechanism would be mainly damping of the magnetosonic waves. Author

N68-18930*# Princeton Univ., N. J. Dept. of Aerospace and Mechanical Sciences.

PULSED ELECTROMAGNETIC GAS ACCELERATION Semiannual Progress Report, 1 Jul.–31 Dec. 1967

Robert G. Jahn and Woldemar F. von Jaskowsky 1 Jan. 1968 131 p refs

(Grant NsG-306-63)

(NASA-CR-93542; SAPR-11; Rept.-634J) CFSTI: HC $3.00/MF $0.65 CSCL 20I

Current sheet transition from a propagating "sweeping" mode to a quasi-steady "blowing" mode has been studied in detail in a parallel plate accelerator with partially insulated electrodes, and in a coaxial MPD arc configuration. In the parallel plate device, a related sequence of magnetic and electric probe surveys, Kerr-cell photographs, inner and outer voltage signatures concur on a model of the transition process which invokes incompletely accelerated gas passed over by the propagating sheet as a starting inflow for the later, steady acceleration phase. The characteristic time for attainment of steady gasdynamic flow through the arc from an external reservoir considerably exceeds that for stabilization of the discharge current pattern, thus requiring longer driving current waveforms and more sophisticated gas injection procedures to achieve complete simulation of a steady flow accelerator. Author

N68-18942# Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.

REVIEW OF RESEARCH ON HOT PLASMA IN THE PLASMA PHYSICS AND TECHNICS DEVISION [PRZEGLAD PRAC BADAWCZYCH Z ZAKRESU FIZYKI GORACEJ PLAZMY WYKONANYCH W ZAKLADZIE FIZYKI I TECHNIKI PLAZMY IBJ]

Michal Gryzinski, Jerzy Nowikowski, Marek Sadowski, and S. Suckewer 1967 66 p refs In POLISH

(INR-P-846/18/PP)

The main trends of research on hot plasma physics being carried out in the Institute of Nuclear Research at Swierk are discussed. The experimental arrangements as well as the diagnostic methods used and general technical problems are described. A review of theoretical studies is also given. NSA

N68-19005*# National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York.

GROWTH AND DECAY OF MAGNETIC FIELDS IN TURBULENT FLUIDS

John J. Cocke Mar. 1968 29 p refs

(NASA-TM-X-60924) CFSTI: HC $3.00/MF $0.65 CSCL 20I

The magnetohydrodynamic properties of random, stationary turbulence are studied. If the fluid is highly conducting and the magnetic field weak, the logarithm of the field strength is shown

to be a random-walk variable to which the central limit theorem applies. The behavior of infinitesimal material displacements which move frozen in the fluid, and which are, on the average, stretched by the turbulence is investigated. Plausible extension to high ohmic dissipation is made, and we conclude that in the absence of a large-scale Fourier component, the ohmic loss destroys the field. An experiment is proposed to test these conclusions. Author

N68-19009# Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires.

IONIZATION STUDY OF HYDROGEN IN A PULSED DISCHARGE [ETUDE DE L'IONISATION DE L'HYDROGENE DANS UNE DECHARGE PULSEE]

Claude Breton (Ph.D. Thesis—Paris Univ.) 3 Feb. 1967 103 p refs In FRENCH
(CEA-R-3185; EUR-3438)

The time variation of the spectral line intensities for molecular and atomic hydrogen in pulsed discharges is interpreted in terms of a model describing the instantaneous population densities of each of the species: H_2, H_2, H_3, excited atoms in a level j, electrons and protons. Every possible reaction is taken into account. For plasma diameters of about 25 cm and particle densities of the order of 10^{14} cm^{-3} it is necessary to introduce transient line absorption coefficients. It is found experimentally that the model describes the observed phenomena reasonably well. From the calculations a method for electron temperature measurement is deduced which uses a single oscillogram giving H_β line intensity versus time. Author (NSA)

N68-19045# Commissariat a l'Energie Atomique, Fontenay-Aux-Roses (France). Centre d'Etudes Nucleaires.

INJECTION AND TEMPORARY CAPTURE OF A CHARGED PARTICLE BEAM IN AN OPEN MAGNETIC CONFIGURATION. OPTIMIZATION OF THE CONFIGURATION. CASE OF CYLINDRICAL SYMMETRY: A MIRROR MACHINE [ETUDE DE L'INJECTION ET DE LA CAPTURE TEMPORAIRE D'UN FAISCEAU DE PARTICULES CHARGEES DANS UNE CONFIGURATION MAGNETIQUE OUVERTE. OPTIMISATION DE LA CONFIGURATION. CAS DE LA SYMETRIE DE REVOLUTION: MACHINE A MIROIRS]

Pierre Capdequi-Peyranare (Ph.D. Thesis—Paris Univ.) 1967 126 p refs In FRENCH
(CEA-R-3197; EUR-3437)

A new method of transverse injection of charged particles into a magnetic mirror configuration permits the penetration and temporary capture by nonadiabatic effect of a particle beam of approximately 1-cm^2 cross section. The original programs for IBM 7094 computer calculations were used to obtain an optimization of the configuration. The results of a statistical numerical study of the optimum configuration indicate that, if the energy of the particles of the beam is about 1% greater than a minimum penetration energy, the entire beam can be captured with an average capture length of 100 meters (50 reflections between the two mirrors). If the energy is about 4% greater than the minimum penetration energy, the capture length is reduced to 40 meters. The distribution of energy transverse and longitudinal with the magnetic field for the population of captured particles was studied. For the cases of injected molecular hydrogen ions or heavy CH_4^+ ions, a study was made of the capture time of protons resulting from the dissociation of the ions by collisions with the neutral gas. Finally, a model experiment using electrons designed to provide verification of the capture of the primary beam is described. Author (NSA)

N68-19050# United Aircraft Corp., East Hartford, Conn. Research Labs.

[PRODUCTION OF PLASMAS FOR THERMONUCLEAR RESEARCH BY LASER BEAM IRRADIATION OF SOLID PARTICLES. REVIEW OF CURRENT RESEARCH PROGRAM]

Progress Report
A. F. Haught Nov. 1967 34 p refs
(Contract AT(30-1)-3578)
(NYO-3578-7) CFSTI: HC $3.00/MF $0.65

AEC and corporate-sponsored investigations on the production of plasma from laser-beam irradiation of solid particles are described. Various aspects of the plasma properties are discussed. NSA

N68-19082*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

KINETIC THEORY OF INHOMOGENEOUS SYSTEMS

John C. Price Mar. 1968 66 p refs
(NASA-TM-X-63131; X-641-68-89) CFSTI: HC $3.00/MF $0.65 CSCL 20I

A theory is developed which treats the coupled equations of the various hierarchies as simultaneous equations in time. This scheme proceeds by successive approximations rather than a power series expansion in the small parameter. The theory is suitable for the derivation of equations for non-uniform and force driven systems. Examples are given for a plasma and a Boltzmann gas. Author

N68-19121 Texas Univ., Austin.

HIGH POWER RF PLASMA HEATING AND WAVE PROPAGATION NEAR THE FUNDAMENTAL AND HARMONICS OF THE ION CYCLOTRON FREQUENCY

Magne Kristiansen (Ph.D. Thesis) 1967 149 p
Available from Univ. Microfilms: HC $7.00/MF $3.00 Order No. 67-8120

Generation, propagation, and damping of fundamental and harmonic ion cyclotron waves were investigated experimentally and theoretically. A "magnetic beach" geometry is used and the waves are excited by a Faraday shielded Stix coil from a 30 kW, 5.8 MHz driver. The plasma loading of the Stix coil, the cut-off conditions for the fast wave, and optimum coupling conditions were calculated and measured. It was observed that for certain experimental conditions the ion cyclotron waves propagate for frequencies above the ion cyclotron frequency f_c. The harmonic number G at which the waves attenuate is found to be pressure dependent such that G increases for increasing gas pressure. Both hydrogen and deuterium plasmas were investigated. Spatial measurements of the wave magnetic fields were made with magnetic probes for several plasma densities and confining magnetic fields in a "magnetic beach" geometry. A discussion of the observed phenomena is presented. It is shown that a higher order transverse mode structure may be expected under experimental conditions similar to those reported here. Dissert. Abstr.

N68-19141*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

SOLUTION OF THE BOLTZMANN AND RATE EQUATIONS FOR THE ELECTRON DISTRIBUTION FUNCTION AND STATE POPULATIONS IN NONEQUILIBRIUM MHD PLASMAS

J. V. Dugan, Jr., F. A. Lyman, and L. U. Albers Washington 1968 20 p refs Presented at Intern. Symp. on Magnetohydrodyn. Elec. Power Generation, Sponsored by Intern. Atomic Energy Agency and European Nucl. Energy Agency, Salzburg, Austria 4-8 Jul. 1966
(NASA-TM-X-52190; SM-74/191) CFSTI: HC $3.00/MF $0.65 CSCL 20I

This paper reports preliminary results of an investigation undertaken to establish the range of validity of the two-temperature theory for MHD plasmas by solving the Boltzmann equation and the steady-state rate equations for the bound electronic states. First, f(u) was calculated from a Boltzmann equation including only the electric field and the elastic collision terms. The results showed

that for typical MHD systems electron-electron collisions drive (fu) to maxwellian. Second, the solution of the rate equations for a maxwellian f(u), using a five-level cesium atomic model, demonstrated the importance of radiative transitions in determining the bound-state populations and magnitudes of the inelastic collision terms. The model atom consisted of four discrete states: (6S; 6P,P'; 5D,D'; 7S) and a lumped state, which was assigned various binding energies and degeneracies. Both the classical Bohr–Thomson and Gryzinski cross sections were used to calculate the rate coefficients and collision terms for excitation, deexcitation, ionization, and three-body capture. Finally, the simultaneous solution of the Boltzmann equation and the bound-state rate equations was attempted by an iterative technique. Plasmas of various optical thicknesses to resonance radiation were considered. Author

N68-19204 Stanford Univ., Calif.
ONE AND TWO-DIMENSIONAL STEADY STATE LOW PRESSURE DISCHARGE THEORY
Elden K. Shaw (Ph.D. Thesis) 1967 172 p
Available from Univ. Microfilms: HC $8.00/MF $3.00 Order No. 67-7967

In this work it is shown that a pressure theory approach, although approximate, when modified to take into account ion generation can be used to accurately describe a wide variety of dc discharges in the low- and medium-pressure regimes. This modified pressure theory or fluid approach makes use of the "moment method" of solution of the Boltzmann equation to obtain differential equations which describe low pressure discharges in terms of measurable macroscopic parameters. Solutions are found for the parameters of the discharges in one-dimensional planar, cylindrical, and coaxial geometries for various generation rates and including both the effects of ion-neutral collisions and an applied magnetic field. The results for the one-dimensional collisionless cases are compared with the more exact formulation of Langmuir and found to be in good agreement. Dissert. Abstr.

N68-19274*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE IDENTIFICATION OF MOVING MAGNETIC FIELD LINES
Thomas J. Birmingham and Frank C. Jones Feb. 1968 16 p refs
(NASA-TM-X-63123; X-641-68-68) CFSTI: HC $3.00/MF $0.65 CSCL 20I

Magnetic field line motion and its relationship with particle $\underset{\sim}{E}\times\underset{\sim}{B}$ drifts are considered. It is shown that a unique and significant field line identification can be made whenever all field lines in a region pierce a conducting, but arbitrarily shaped surface. If the region in question is free space, particle electric drifts, in general, bear no relation with field line motion identified in this fashion. However, with a conducting plasma filling the region and allowing no parallel component of electric field ($\underset{\sim}{E}\cdot\underset{\sim}{B}=0$), particles drift so as to always remain on the same magnetic line of force. These points are specifically illustrated for a time-dependent model of the earth's magnetosphere. Author

N68-19280 California Inst. of Tech., Pasadena.
A NONLINEAR STUDY OF BEAM PLASMA AMPLIFICATION
Robert Leslie Poeschel (Ph.D. Thesis) 1967 122 p
Available from Univ. Microfilms: HC $6.00/MF $3.00 Order No. 67-8980

The interaction between an electron beam and the plasma oscillations it excites in traversing a plasma region effectively changes the magnitude and direction of the force between beam electrons. This effect has been studied theoretically and experimentally by computing and observing beam electron velocities and phases for a beam which is initially velocity modulated at frequency ω and allowed to drift through a plasma filled region of plasma frequency ω_p. When $\omega > \omega_p$ the force between electrons is repulsive and effectively increases in magnitude as ω approaches ω_p. When $\omega < \omega_p$ the force between electrons becomes a force of attraction, to within a given interelectron spacing, and the maximum effect is also at the resonance condition $\omega \approx \omega_p$. This property could be used to improve the efficiency of electron bunching in a klystron type amplifier by filling the drift space with a plasma of appropriate density. Dissert. Abstr.

N68-19488# Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
INVESTIGATIONS OF GAS-CONDITIONS IN THE OPERATION OF A COAXIAL PLASMA INJECTOR [BADANIA WARUNKOW GAZOWYCH PRZY PRACY KAOKSJALNEGO INIEKTORA PLAZMONEGO]
Zbigniew Kozlowski and Marek Sadowski 1967 39 p refs
(INR-861/18/PP) CFSTI: HC $3.00/MF $0.65

The paper presents an analysis of the composition of residual gas in the experimental chamber under stationary conditions. Examined are also variations in gas composition and partial pressures following the operation of a fast gas valve, as also such as are due to the discharge process in the plasma injector. It is established that the basic sources of plasma impurities are the processes of gas desorption from the walls of the experimental chamber, as also the decomposition of heavy particles of oil vapours penetrating from the vacuum pumps. The propagation velocities of the working gas puff admitted into the injector and the pressure time-characteristics are also determined. It is further established that, during the plasma generating discharge, there occurs a sorption activation of walls and an exchange of gases between the plasma and a fraction of the internal surfaces of the system. Author

N68-19489# Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
EXPERIMENTAL STUDIES OF A COAXIAL PLASMA INJECTOR. 1: STUDY OF OPERATIONAL CONDITIONS [EKSPERYMENTALNE BADANIA KOAKSJALNEGO INIEKTORA PLAZMOWEGO. 1: OKRESLENIE WARUNKOW EKSPLOATACJI]
Marek Sadowski and Elzbieta Skladnik-Sadowska 1967 27 p refs
(INR-850/18/PP) CFSTI: HC $3.00/MF $0.65

The paper describes investigations on the optimization of the parameters and operational conditions of a coaxial plasma injector. A detailed description of the experimental system is given, and the results of measurements performed by means of magnetic probes and a high-speed camera are discussed. The velocities of plasmoids emitted are determined and the regime of efficient operation of the injector is established. Author

26 PHYSICS, SOLID-STATE

Includes semiconductor theory; and superconductivity. For applications see: 16 Masers. For related information see also: 10 Electronics.

N68-18259# Massachusetts Inst. of Tech., Cambridge. Dept. of Electrical Engineering.
MAGNETOELASTIC PARALLEL-PUMP INSTABILITIES FOR GENERALLY DIRECTED WAVES

Peter H. Cole Apr. 1967 43 p refs
(Contract AF 19(6281-5876)
(AFCRL-67-0663; SR-8; AD-664329)

A general analysis of the longitudinal pumping of magnetoelastic waves near the magnon phonon crossover region has been performed. Variations in the direction of propagation and applied field within the crystal lattice are taken into account and the effects of magnetic, elastic and magnetoelastic anisotropy are included. By considering competition from magnetoelastic waves with propagation directions which are not quite transverse to the applied field the results of parallel pumping experiments may be reconciled with the measurements of magnetoelastic constants performed at lower frequencies by other methods, and high frequency elastic Q factors determined. Author (TAB)

N68-18261# Controls for Radiation, Inc., Cambridge, Mass.
PHOTOACTIVATION OF CERIUM, NEODYMIUM, SAMARIUM AND GADOLINIUM
Gunter H. R. Kegel Oct. 1967 66 p refs
(Contract AF 19(628)-5980)
(AFCRL-67-0595; SR-3; AD-664347)

The report presents reference data for activation analysis of cerium, neodymium, samarium, and gadolinium. Samples of approximately 1 gram each of cerium oxide, neodymium oxide, samarium oxide, and gadolinium oxide, were irradiated on the AFCRL linear accelerator with a bremsstrahlung beam. Conditions of irradiation are reported. Induced activities were measured with a gamma spectrometer, using a lithium drifted germanium detector. Results of these measurements are discussed and minor revisions in the decay schemes of Ce135, Nd141, Nd149, and Gd159 are proposed. The standard analytical sensitivity for cerium, neodymium, samarium, and gadolinium determinations is defined as the mass of the element which yields an activity of 1000 disintegrations per minute. These sensitivities vary from 0.2 mg (neodymium to 30 mg cerium). Author (TAB)

N68-18269# Aerospace Corp., El Segundo, Calif. Lab. Operations.
UTILITY OF THE STAGNANT FILM CONCEPT OF MASS TRANSFER IN CRYSTAL GROWTH, JULY–SEPTEMBER 1967
William R. Wilcox Oct. 1967 21 p refs
(Contract F04695-67-C-0158)
(TR-0158(9230-03)-1; SAMSO-TR-67-125; AD-664061)

Crystal growth generates a flow of material toward and through the crystal surface. An investigation is made of the effect of this interfacial flow on the thickness of the imaginary stagnant layer of fluid through which mass transfer must take place. The film thickness is found to be relatively independent of interfacial flow for laminar-free convection of a liquid on a vertical flat plate and for a rotating disk in a gas. It varies significantly, however, for other situations, especially with laminar-forced convection of a gas over a flat plate. Mass-transfer calculations, taking into account interfacial flow, are outlined for solution crystal growth and for controlled solidification. Author (TAB)

N68-18311# ITT Industrial Labs., Fort Wayne, Ind.
INVESTIGATION OF STRONTIUM TUNGSTATE MIXED CRYSTAL CATHODE Triannual Report No. 1, 26 Apr.–26 Aug. 1967
Bernard W. Byrum, Lozure G. Wolfgang, and J. L. Gumnick Dec. 1967 30 p refs
(Contract DAAB07-67-C-0381)
(ECOM-0381-1; RM-7-456; AD-664186)

The purpose of the work described is to investigate the formation and characteristics of strontium-tungstate mixed crystal cathodes. The objective is the realization of a lower work function in a cathode which is relatively rugged compared with conventional oxide cathodes. Richardson plots and retarding field electron beam techniques were used to evaluate the work functions of sample cathodes. All cathodes were made by spraying the mixed materials onto a metallic substrate. Combinations prepared and evaluated were: strontium carbonate ($SrCO_3$) on W, $SrCO_3$ + W on Ta, $SrCO_3$ + W on Ta with an $SrCO_3$ underlayer, $SrCO_3$ + W on Ta with a nickel intermediate, Sr_3CO_3 + W on Ni, and $SrCO_3$ + W on P-50 nickel alloy. Author (TAB)

N68-18315# Massachusetts Inst. of Tech., Cambridge. Microwave and Quantum Magnetics Group.
MAGNETOELASTIC AND MAGNETOSTATIC WAVES IN TIME-VARYING MAGNETIC FIELDS Interim Scientific Report
Sergio M. Rezende Dec. 1967 129 p refs
(Contract AF 19(628)-5876)
(AFCRL-67-0681; SR-10; AD-664333)

The propagation of microwave magnetoelastic and magnetostatic waves in a ferromagnet subjected to pulsed magnetic fields is investigated both theoretically and experimentally. In the first part of the theoretical analysis, which is restricted to spatially uniform bias fields, the coupling between the magnetic and elastic systems is neglected. Using a coupled mode approach, it is found that plane spin waves propagate in magnetic field transients with negligible reflections, constant momentum and wavenumber, but variable frequency and power flow. These results are further elucidated by the study of a simple step transient case. The analysis is also extended to magnetostatic modes propagating in axially magnetized cylinders. In the presence of magnetoelastic interaction, the theory indicates that besides changes in frequency and in power flow, the field gradient causes group velocity modulation and changes in the time duration of wave packets. In addition there is an exchange of momentum between the different branches of the dispersion relation; this exchange is calculated in terms of critical field gradients. These critical gradients are given for both shear and longitudinal waves propagating along certain crystallographic directions. Experiments with magnetoelastic pulses in axially magnetized YIG rods confirm the theoretical predictions. Author (TAB)

N68-18361# California Univ., Los Angeles. Dept. of Physics.
ENERGY LEVELS AND VIBRONIC INTENSITIES IN CRYSTALS HAVING U^{4+} HALIDE COMPLEXES
Charles Leonard Schreiber Nov. 1967 197 p refs
(Contract DA-31-124-ARO(D)-219; Grants DA-ARO(D)-31-124-G75; DA-ARO(D)-31-124-G927)
(TR-6; AROD-2099.31-P; AD-664181) CFSTI: HC $3.00/MF $0.65

A study was made of the vibronic absorption spectra of $(CH_3)_4N)_2UCl_6$, Cs_2UCl_6, and Cs_2UBr_6 salts. The similarities observed in these spectra both in the intensities and in the transition energies are shown to be based on the existence of a tightly bonded $UX_6^{(2-)}$ halide complex which has a large crystal field with octahedral O_h symmetry interacting with the uranium ion. A diagonalization of the Hamiltonian containing the electrostatic, spin-orbit, and crystal field interactions within a basis of states from the 5f(2) configuration of the $U^{(4+)}$ free ion is made and the eigenvalue spectrum for the low-energy electronic states (within 4 ev of the ground state) is fitted to within an average deviation of 130/cm. The vibronic interaction Vev between the electronic and vibrational states of the crystal is approximated by a model involving the odd vibrational modes of the $UX_6^{(2-)}$ complex. The intermediate states mixed into the 5f(2) states by this vibronic interaction are used to obtain electric dipole vibronic transitions. Several selection rules which limit the useful intermediate states and the allowed vibronic transitions are discussed. Author (TAB)

N68-18362# New Mexico Univ., Albuquerque. Dept. of Chemistry.
FUNDAMENTAL INVESTIGATIONS OF LUMINESCENT MATERIALS Final Report, 1 Jan. 1963–14 Sep. 1967

G. A. Crosby 15 Jan. 1968 21 p refs
(Grants AF-AFOSR-269-63; AF-AFOSR-269-63A; AF-AFOSR-269-65; AF-AFOSR-269-67)
(AFOSR-68-0213; AD-664276)

The main purpose of the research was to study the fundamental processes occurring in luminescent materials after the primary act of energy absorption. A second objective was to search for new luminescent substances of possible technological importance guided by the criteria established by concomitant fundamental studies on energy transfer. Numerous complexes of ruthenium(II), cobalt(III), osmium(II), iridium(III), rhodium(III), and platinum(IV) having pi-conjugated ligands were studied spectroscopically. Many of the materials were discovered to be highly-efficient, photochemically-stable, luminescent substances. Some of them exhibit properties which suggest potential value as active materials for electrooptical and laser devices. General experimental criteria were formulated which can be used to aid significantly in the task of making state assignments for new luminescent complexes of transition metals. Triplet states in rhodium complexes which are inaccessible by absorption measurements were located experimentally via emission spectroscopy. Author (TAB)

N68-18364# Utah Univ., Salt Lake City. Inst. for the Study of Rate Processes.
PROPERTIES OF MATTER UNDER HIGH PRESSURES AND TEMPERATURES Final Report, 12 Dec. 1961–11 Dec. 1967
Henry Eyring and Terrell N. Andersen 11 Dec. 1967 9 p refs
(Grants DA-ARO(D)-31-124-G243; DA-ARO(D)-31-124-G508; DA-ARO(D)-31-124-G618)
(AROD-2759.19-C; AD-664177) CFSTI: HC $3.00/MF $0.65

A summary is given of studies involving the effects of pressure and temperature on the electrical properties of solids, chemical reactions and kinetics, phase transitions, and x-ray diffraction. A list of published papers resulting from the work is included. TAB

N68-18392# Naval Research Lab., Washington, D. C.
MEASUREMENT OF ATOMIC KINETICS OF SOLIDIFICATION USING PELTIER HEATING AND COOLING
R. J. Schaefer and M. E. Glicksman 5 Dec. 1967 23 p refs
(ARPA Order 418)
(NRL-6637; AD-664206)

Periodic Peltier heating and cooling may be generated at a solid/liquid interface by the passage of an alternating electric current. Melting and freezing will then occur at rates which will be influenced by the kinetic law of molecular attachment relating solidification velocity to interface temperature. The equation describing the interface attachment kinetics may be determined by measuring the response of a solid/liquid interface to square-wave Peltier heating and cooling. The mathematical methods required for extracting the kinetic equation by analysis of the waveform of interface motion show that this technique should give distinguishably different waveforms for linear, parabolic, and exponential kinetics. There are advantages of the method, but precautions must be taken to eliminate possible confusing effects. Author (TAB)

N68-18400# IIT Research Inst., Chicago, Ill.
EXCESS NOISE IN SEMICONDUCTORS Annual Summary Report, 15 Nov. 1966–14 Nov. 1967
James J. Brophy 14 Nov. 1967 83 p refs
(Contract N00014-66-C-0032)
(ASR-2; AD-664513) CFSTI: HC $3.00/MF $0.65

An experiment to detect optical absorption fluctuation in germanium caused by variations in free carrier scattering associated with 1/f-type carrier fluctuations has been undertaken. The sensitivity limit of the experiment, internal noise in the infrared detectors, is reduced by including the sample in an optical interferometer and placing the detector in a dark fringe. Further reduction below the detector dark noise level is obtained by using two detectors and cross-correlating the individual output signals. The desired signal has not yet been observed because of the poor detectivity of lead sulfide detectors at the 3.39 micron laser wavelength used to probe the sample. Author (TAB)

N68-18424# Controls for Radiation, Inc., Cambridge, Mass.
ELECTRICAL MEASUREMENTS AND NUCLEAR ACTIVATION TECHNIQUES FOR RADIATION DAMAGE STUDIES AND IMPURITY ANALYSIS IN SILICON AND IN LASER MATERIALS Final Report, 9 Mar. 1966–9 Oct. 1967
Richard W. Peterson, Ralph B. Soper, Sumner Mayburg, and Gunter H. R. Kegel 9 Nov. 1967 90 p refs
(Contract AF 19(628)-5980)
(AFCRL-67-0596; AD-664325)

The most favorable nuclear method for detecting carbon, nitrogen and oxygen in silicon at the parts per million level (ppm) was determined to be charged particle activation. A sputtering mass spectrography offers potential for ppm detection as well. Infrared techniques detect only that fraction of the impurity which is properly located in the lattice to contribute to the infrared vibration while nuclear techniques and mass spectrography detect all the impurity present. The uniformity of dopants in an Al spectroscopic standard has been studied for the dopants Mn, Ga, and Cu by neutron activation. For 100 micro-gram samples a standard deviation of 2% was determined for the method. Within this error Mn and Ga were found to be uniformly distributed while the Cu was not. Recent advances in electro probe analysis appears to make this method more desirable than nuclear activation because with nuclear techniques interfering activities limit the number of impurities that can be determined. Techniques for fabrication of Hall bars for radiation damage studies were developed. A P.M.E. null technique was improved by use of a blue argon laser in order to measure lifetimes below one micro-sec. in silicon Hall samples. A laser test facility was constructed for rare earth doped materials. Gamma ray activation was developed for analyzing for trace amounts of samarium, gadolinum, neodymium and cerium. Author (TAB)

N68-18448# California Univ., Los Angeles. Dept. of Engineering.
RESEARCH ON SOLID STATE HETERODYNE DETECTORS FOR ULTRASTABLE OPTICAL SOURCES Annual Report, 15 Jun. 1966–15 Jun. 1967
C. R. Viswanathan Dec. 1967 22 p refs
(Contract DA-28-043-AMC-02341(E))
(Rept.-67-57; ECOM-02341-2; AD-664197)

Photo emission from solid to solid in MOS structures has been studied in a silicon-siliconoxide-gold structure. This study gave insight into the location of the silicon dioxide conduction band with respect to the silicon energy bands. It was also found that the number of traps is higher in p samples than in n samples. Photoemission from solids into vacuum was studied and the method of periodic Schottky deviation has been used as a tool for evaluating surface barriers of metals. By using phase matching instead of amplitude matching between the predicted curve and the experimental curve a barrier height of 7.4, 6.1 and 5.2 ev for Rhenium, Tungsten, and Molybdenum was obtained. Author (TAB)

N68-18520 Pennsylvania Univ., Philadelphia.
STRUCTURE OF THE JOSEPHSON CURRENT PRODUCED BY AN ELECTROMAGNETIC FIELD AND FREE INDUCTION DECAY IN A MAGNETICALLY DILUTE SOLID
Tsu-ming Wu (Ph.D. Thesis) 1966 127 p
Available from Univ. Microfilms: HC $6.20/MF $3.00 Order No. 67-7883

Part One: Structure of the Josephson Current Produced by an Electromagnetic Field—Within the Valatin–Bogoliubov quasi-particle approximation, Riedel has recently shown that the amplitude of the ac Josephson current has a logarithmic singularity when the bias voltage $V_0 = 2\Delta_0/e$. Here we investigate the Josephson current amplitude in the presence of an external electromagnetic field using the Nambu–Eliashberg Green's function formalism. The introduction of Green's functions allows us to take account of damping and retarded nature of the electron–phonon interaction. Part Two: Free Induction Decay in a Magnetically Dilute Solid—We investigate theoretically the beat structure in the free induction decay for a magnetically dilute system. For simplicity we consider an isotropically disordered cubic lattice having a fraction p of lattice sites occupied by spin 1/2 nuclei and the remaining sites occupied by spin zero nuclei. A perturbation calculation of the free induction decay in powers of the rotationally invariant part of the truncated dipolar interaction is carried out. This is an adaption of the Lowe and Norberg calculation to the case of a magnetically dilute system. Dissert. Abstr.

N68-18525 Texas Univ., Austin.
TUNNELING BETWEEN A METAL AND SILICON SEPARATED BY A POLYMER INSULATOR
Carl William Wilmsen (Ph.D. Thesis) 1967 138 p
Available from Univ. Microfilms: HC $6.60/MF $3.00 Order No. 67-8173

This research investigates tunneling between a metal and silicon separated by an insulator (MIS structure) and develops a model describing the MIS current-voltage characteristics. Analysis shows that any model for MIS tunneling must consider the density of surface states and the formation of a depletion or accumulation layer in the silicon. The model shows that the electric field in the insulator controls the MIS current while the charge distribution in the silicon determines the insulator field. For the experimental results presented in this paper a polymerized film formed the insulator. After establishing the technique of forming the polymer, metal–insulator–metal (MIM) junctions enabled study of the electrical properties of the polymer and characterization of MIM tunneling currents. The MIM characteristics permitted comparative analysis with MIS structures. Dissert. Abstr.

N68-18554# Westinghouse Electric Corp., Pittsburgh, Pa. Research Labs.
HIGH ENERGY CRYSTALLINE LASER MATERIALS Final Technical Summary Report, 16 Oct. 1965–3 Mar. 1967
R. C. Ohlmann, R. Mazelsky, and J. Murphy 1 Dec. 1967 60 p refs
(Contract Nonr-4658(00); ARPA Order 306)
(AD-664467)

A potential high energy laser material, GdAlO3 doped with chromium, is discussed in terms of its growth problems and spectroscopic characteristics. Crystals were successfully pulled from the melt. The fluorescence of Cr(3+) has an 18 msec decay time and a broad R-line. The width and structure of the R-lines are theoretically described as due to the ferromagnetic exchange interactions with neighboring Gd(3+) ions. Author (TAB)

N68-18558# Massachusetts Inst. of Tech., Cambridge. National Magnet Lab.
SEARCH FOR FERROMAGNETICALLY TRAPPED DIRAC MONOPOLES OF COSMIC RAY ORIGIN
Henry H. Kolm 2 Nov. 1967 7 p Presented at Conf. on the Appl. of Phys. to the Earth and Planetary Interiors, Newcastle-upon-Tyne, Engl.
(Contract AT(30-1)-3828)
(MIT-3828-1; CONF-670328-1) CFSTI: HC $3.00/MF $0.65

Progress is reported on the search for magnetic monopoles in ferromagnetic materials. The refinement of the apparatus to a confidence level adequate to ensure detection of a single monopole of charge greater than one sixth the charge predicted by Dirac, and mass greater than one tenth atomic mass unit, is reported. NSA

N68-18567# Cornell Univ., Ithaca, N. Y. Materials Science Center.
FIELD ANALYSIS OF A SUPER CONDUCTING SOLENOID MAGNET UTILIZING NUCLEAR MAGNETIC RESONANCE
Edward Eugene Steele (M.S. Thesis) Jan. 1968 70 p refs
(Contract AT(30-1)-2150)
(NYO-2150-36; Rept.-821) CFSTI: HC $3.00/MF $0.65

$Nb_{75}Zr_{25}$, a type-II superconductor, has been found to be a suitable material out of which to make superconducting magnets. These magnets are capable of producing very large magnetic fields (>10 kG). Several of the properties of such magnets are investigated. The nature of the superconducting state of type-II superconductors is also investigated. The critical fields and the critical temperature of the type-II alloy $Pb_{85}In_{15}$ are measured. This PbIn alloy was used purely to simplify the experimental procedure; the results are applicable to other type-II materials, and, in particular, to NbZr. A field calibration technique which utilizes nuclear magnetic resonance is described. A marginal oscillator system is used which is capable of measuring fields from 1.5 to 60 kG easily. Suggestions of possible improvements over the present system are made. The homogeneity, linearity, reproducibility, and hysteresis of a 55-kG Westinghouse uncorrected solenoid magnet are studied with this NMR calibration system. The results are compared to field calculations based on the geometry of the solenoid. The field characteristics of the superconducting solenoid are also compared with iron electromagnets and Bitter magnets. Author (NSA)

N68-18606# Brandeis Univ., Waltham, Mass. Dept. of Physics.
EXPERIMENTAL STUDIES OF CRITICAL POINT BEHAVIOR IN MAGNETICALLY ORDERED SOLIDS USING NUCLEAR GAMMA-RAY SPECTROSCOPY Annual Progress Report, 1 Feb.–31 Oct. 1967
Christoph Hohenemser 31 Oct. 1967 5 p refs
(Contract AT(30-1)-3823)
(NYO-3823-1; APR-1) CFSTI: HC $3.00/MF $0.65

A slow–fast delayed coincidence system was set up. An effort was made to improve the time resolution for both plastic and NaI scintillators. A vacuum annealing oven was designed and constructed. A preliminary perturbed angular correlation experiment using the 122–14 keV cascade in ^{57}Fe is proceeding. NSA

N68-18608# Lyon Univ. (France).
BEHAVIOR OF SILICON SINGLE CRYSTALS AND SURFACE BARRIER JUNCTIONS UNDER FAST NEUTRON IRRADIATION [COMPORTEMENT DE MONOCRISTAUX DE SILICIUM ET DE JONCTIONS A BARRIERE DE SURFACE SOUS IRRADIATION AUX NEUTRONS RAPIDES]
Daniel Drain (Ph.D. Thesis) Jul. 1967 p 51 refs In FRENCH
(LYCEN-6756)

Two methods for studying the effects of radiation on semiconductors, particularly of fast neutrons on n-type silicon, were used: one consists of observing the variations of the electrical properties of the semiconductor due to the appearance of faults in the irradiated crystal and the other is the study of the modifications of the properties of p-n junctions, which makes it also possible to define the limits of utilization of junction detectors when they are exposed to fast neutron irradiation. The process of the creation of faults in semiconductors is first reviewed. The measurements made of the resistivity and Hall effect making it possible to obtain the physical parameters characterizing the monocrystal and their

modifications under irradiation are described. The evolution of the electrical properties of p-n junction detector was followed. NSA

N68-18627# Royal Aircraft Establishment, Farnborough (England).
THE THERMOELECTRIC EMF OF MERCURY RELATIVE TO PLATINUM
R. H. Stanford Aug. 1967 10 p refs
(RAE-TR-67185; AD-664316)

It has been suggested that published values for the thermal emf of mercury relative to platinum were incorrect and hitherto no values were available at temperatures below 0 deg. C. Equipment was designed and calibrations made in the range -35 to +200C reproducible to +0.5 or -0.5 deg C. Above 0 deg. C results are about an order lower than published values. Below 0 deg. C two reversals of polarity occur whilst at the freezing point (-38.87C) there is a sudden inversion of the rate of change of emf with temperature. Reproducibility below this point was found to be not better than +2 or -2 deg. C. Author (TAB)

N68-18740# Laboratoire de Physique des Solides, Orsay (France). Faculte des Sciences.
BAND PARAMETERS DETERMINATION FROM FARADAY ROTATION MEASUREMENTS
M. Balkanski and E. Amzallag 31 Jul. 1967 31 p refs
(Contract AF 61(052)-757)
(ARL-67-0284; SR-3; AD-664582)

It is the purpose of the review to summarize some of the recent theoretical and experimental work on free-carriers and interband Faraday rotation, and to examine the difficulties encountered and the results obtained since the formulation of the effect in semiconductors. Author (TAB)

N68-18760# Rome Univ. (Italy).
ELASTIC WAVE EXCITATION IN PIEZOELECTRIC SLABS
F. Bardati, G. Barzilai, and G. Gerosa 22 Jul. 1967 18 p refs
(Contract AF 61(052)-807)
(AFCRL-67-0526; SR-5; AD-664068)

The problem of a plane uniform electromagnetic wave travelling in a vacuum region and obliquely impinging on a piezoelectric slab bounded on the opposite side by an elastic medium was considered. The power carried by the elastic wave transmitted in this last elastic medium was computed for various values of the geometrical parameters and the maxima determined. Author (TAB)

N68-18772*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
LIGHT-INDUCED MODULATION OF ABSORPTION (LIMA) IN CADMIUM SULFIDE
Karl W. Boer and Edmund J. Conway Washington Mar. 1968 11 p refs
(NASA-TN-D-4466) CFSTI: HC$3.00/MF$0.65 CSCL 20L

The bulk optical absorption from 0.5 micrometer to 2 micrometers of cadmium sulfide single crystals has been modulated by a chopped continuous wave laser. Data showing the intensity and chopping frequency dependences are discussed. A few of the implications of these data are also mentioned. Author

N68-18818*# Aztec School of Languages, Inc., Acton, Mass.
APPROXIMATE CALCULATION OF THE SURFACE TENSION OF METALS [PRIBLIZHENNYY RASCHET POVERKHNOSTNOGO NATYAZHENIYA METALLOV]
S. N. Zadumkin Washington NASA Mar. 1968 7 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR, v. 112, no. 3, 1957 p 453–456
(Contract NASw-1692)
(NASA-TT-F-11552) CFSTI: HC$3.00/MF$0.65 CSCL 20L

A method is developed for calculating surface tension in metals on the basis of their heats of vaporization, using a polar model of a metal. A table is given which lists surface tension values for eleven metals and compares the author's results with data from the literature. Author

N68-18941# Oak Ridge National Lab., Tenn. Health Physics Div.
OPTICAL PROPERTIES OF VACUUM-EVAPORATED FILMS OF TELLURIUM AND AMORPHOUS SELENIUM
James David Hayes, Jr., (M.S. Thesis—Vanderbilt Univ.), E. T. Arakawa, and M. W. Williams Jan. 1968 52 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-2023) CFSTI: HC$3.00/MF$0.65

Optical constants were obtained for the films in the ultraviolet spectral region. The optical constants were used to calculate the real and imaginary parts of the complex dielectric constant and the volume- and surface-plasma energy loss functions. NSA

N68-18955*# Rice Univ., Houston, Tex.
SPIN-LATTICE INTERACTIONS OF IONS WITH UNFILLED F-SHELLS MEASURED BY ESR IN UNIAXIALLY STRESSED CRYSTALS
T. D. Black and P. L. Donoho [1965] 12 p refs Submitted for publication
(Grant NsG-6)
(NASA-CR-77668) CFSTI: HC$3.00/MF$0.65 CSCL 20L

The effect of uniaxial stress on the electron-spin-resonance spectra of U^{3+} and Nd^{3+} ions in CaF_2 was investigated. The uniaxial stress was directed along the [001] and [101] axes, and its effects on the spectra of ions in sites of tetragonal symmetry were observed. Measurements were made at a temperature of 4.2°K and at a frequency of 9.4 GHz. The effect of the applied stress was a shift in the position of a resonance line proportional to the magnitude of the stress. The dependence of this shift on the magnitude and direction of the applied magnetic field agreed with that predicted by the inclusion in the spin Hamiltonian of a spin-lattice perturbation of the form, $H_{SL} = \beta h_{ij} S_i H_j$, where h_{ij} is a tensor linearly dependent on the strain in the crystal lattice: $h_{ij} = G_{ijkl} e_{kl}$. In effect, h_{ij} is simply a perturbation added to the normal g-tensor for the ion. For tetragonal symmetry, there are seven independent components of the G-tensor, and these were determined for the ions under consideration. Author

N68-18965# Avco-Everett Research Lab., Everett, Mass.
IMPROVED STABILIZED SUPERCONDUCTORS
A. El Bindari and R. Bernert Mar. 1968 19 p refs
(RR-291)

A theory of the stable transition of a superconductor between normal and superconducting states is reviewed and data supporting this theory is presented. Data on copper-clad Nb-40% Ti is presented, and the slope for the variation of the critical current with wire diameter is found to be 1.5 for wire diameters between .005 and .05 cm. For copper-clad samples of this material, voltage–current data agrees remarkably well with the new theory of stabilization. The importance of the superconducting transitional region is emphasized. Author

N68-18995# Utah Univ., Salt Lake City.
EPR STUDIES OF TITANIUM INTERSTITIALS IN N-TYPE RUTILE

P. I. Kingsbury, W. D. Ohlsen, and O. W. Johnson 2 Sep. 1967 6 p Presented at the Am. Inst. of Phys. Summer Meeting, Seattle, 2 Sep. 1967
(Contract AT(11-1)-1284)
(COO-1284-6; CONF-670951-2) CFSTI: HC $3.00/MF $0.65

A detailed study was made of the four-line spectra to study the defect structure of rutile. The results are discussed. . . . NSA

N68-19025*# Techtran Corp., Glen Burnie, Md.
DIPOLE MOMENT OF THE DOUBLE LAYER OF METALLIC SURFACES [MOMENT DIPOLAIRE DE LA DOUBLE COUCHE DES SURFACES METALLIQUES]
Roger Garron Washington NASA Mar. 1968 3 p refs Transl. into ENGLISH from Compt. Rend. (Paris), v. 256, Mar. 1963 p 2346-2348
(Contract NASw-1695)
(NASA-TT-F-11591) CFSTI: HC $3.00/MF $0.65 CSCL 20L

The dipole moment is evaluated directly, assuming it to be caused by surface electrons. The occupation of surface levels by s-electrons in the fundamental state is linked to the dipole moment of the double layer. Author

N68-19075# Case Western Reserve Univ., Cleveland, Ohio.
SOLID STATE PHYSICS PROGRAM. LOW TEMPERATURE THERMAL EXPANSION COEFFICIENT OF SODIUM FLUORIDE
Kenneth F. Loje May 1967 24 p refs
(Contract AT(11-1)-623)
(COO-623-120; TR-46) CFSTI: HC $3.00/MF $0.65

The linear thermal expansion coefficient, α, for sodium fluoride was measured between 40 and 280°K using a single-crystal, back-reflection X-ray technique. The results are compared with the recent work of James and Yates. A room-temperature value of the Gruneisen parameter, $\gamma = 3\alpha VB_s/C_p$, is calculated and compared with the value obtained by Miller from classic constant measurements. Author (NSA)

N68-19080# Case Western Reserve Univ., Cleveland, Ohio.
SOLID STATE PHYSICS PROGRAM Annual Progress Report
1 Nov. 1967 21 p refs
(Contract AT(11-1)-623)
(COO-623-127) CFSTI: HC $3.00/MF $0.65

Work still in progress on the following subjects is described briefly: torque magnetometer measurements, preparation of thin films for Moessbauer measurements, epitaxy of Cu, Ni, and Al on [111] Si, precision measurement of surface lattice constants, temperature and pressure derivatives of the dielectric constants of the alkali metal halides and alkaline earth fluorides, and theoretical calculations concerning the magnetic properties and lattice dynamics of solids. Technical reports and published papers on completed work are listed, and abstracts are included. NSA

N68-19086# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
SOLID STATE LUMINESCENCE DOSIMETRY: STATE OF THE ART
Walter E. Wilson 13 Dec. 1967 24 p refs Presented at the Conf. on Interdisciplinary Discussion of Solid State Dosimetry, Seattle
(Contract AT(45-1)-1830)
(BNWL-SA-1543; CONF-671121-1) CFSTI: HC $3.00/MF $0.65

The state-of-the-art of solid-state luminescence dosimetry is discussed from two different view points: practical personnel dosimetry and measurements without limitations imposed by measurement methods. Some basic considerations applying to thermoluminescence and radiophotoluminescence are reviewed. The use of these materials as dosimeters is examined. The various materials currently being used, their emission spectra, glow curves, and energy response are discussed. The application of these devices for measuring low-level and high-level doses are described. Author (NSA)

N68-19089# Edgerton, Germeshausen and Grier, Inc., Santa Barbara, Calif.
INFRARED IMAGING OF HEATED EFFLUENTS: A PHOSPHOR RESPONSE STUDY Final Report
R. L. Lynn Jul. 1967 38 p refs
(Contract AT(29-1)-1183)
(EGG-1183-2151; S-388-R) CFSTI: HC $3.00/MF $0.65

A series of luminescent de-excitation experiments to evaluate several classes of phosphors having electroluminescent and thermoluminescent properties are described. The purpose of the measurements was to determine whether these phosphors could be used as infrared-to-visible-light converters based on infrared-stimulated luminescent de-excitation of energy states in the phosphors that had been previously excited by ionizing radiations. The overall purpose has been to develop a capability for long-wave-length (infrared) imaging of cool effluent sources. The techniques used in making the measurements and the resulting data are presented. The results of the experiments have been generally negative. Author (NSA)

N68-19106 North Carolina State Coll., Raleigh.
STUDIES OF CENTERS PRODUCED IN SAPPHIRE AND RUBY BY GAMMA RADIATION
Charles Russell Philbrick (Ph.D. Thesis) 1967 107 p
Available from Univ. Microfilms: HC $5.40/MF $3.00 Order No. 67-7430

The centers produced by gamma radiation in sapphire and ruby crystals have been studied using several experimental techniques. The optical absorption of gamma-radiation-induced center bands has been studied using plane polarized light to investigate the optical properties along axes perpendicular and parallel to the C-axis. This technique allows determination of the anisotropy of the radiation-produced centers. In addition, the results of studies of glow curve measurements, thermoluminescent emission, electrical conduction and step annealing experiments are reported and discussed for the centers produced in ruby and sapphire crystals by gamma radiation. Also, the thermal activation energies of the sapphire centers have been calculated by three different methods and were found to be in agreement. Dissert. Abstr.

N68-19118 Arizona State Univ., Tempe.
THE INTERACTION OF CHROMIUM IONS IN RUBY CRYSTALS
Richard Conger Powell (Ph.D. Thesis) 1967 245 p
Available from Univ. Microfilms: HC $11.05/MF $3.00 Order No. 67-7362

Absorption, excitation, continuous fluorescence, and pulse fluorescence measurements were made on ruby samples with 0.94% and 2.1% Cr^{+3} in the temperature range from 4.2°K up to 700°K. The results are compared with similar measurements on lightly-doped ruby. The widths, positions, intensities, and lifetimes of the R and N fluorescence lines were determined at numerous temperatures. The results for the temperature dependence of the linewidths are explained in terms of microscopic strains, Raman scattering of phonons by the impurity ions, and direct phonon processes. The effects of reabsorption on the fluorescence spectrum were also investigated. Dissert. Abstr.

N68-19127# Osterreichische Studiengesellschaft fur Atomenergie G.m.b.H., Seibersdorf (Austria).
THERMO-DIFFUSE ELECTRON SCATTERING IN ARSENIC, ANTIMONY AND BISMUTH CRYSTALS [THERMISCH-DIFFUSE ELEKTRONENSTREUUNG IN ARSEN, ANTIMON UND WISMUTKRISTALLEN]
E. M. Hoerl 1967 16 p refs In GERMAN Presented at the German Assoc. for Electron Microscop. Symp., Marburg/Lahn, 17–21 Sep. 1967 Submitted for publication
(SGAE-M-13/1967) CFSTI: HC $3.00/MF $0.65

This investigation was aimed at determining the area of high-intensity thermal diffusion in the k space and the phonon frequency conditions. Observed and measured was the intensity distribution of the thermo-diffusive base of the electron diffraction patterns, followed by an evaluation of the resulting data in terms of the kinematic theory of thermo-diffuse scattering of X-rays. Electron diffraction patterns were obtained of arsenic, antimony, and bismuth crystals in various states of orientation at room temperature. Strong overexposure of the Bragg reflexes permitted visualization of the thermo-diffuse base structure of all crystals. The structure appeared in arsenic in the form of diffusive lines or diffusive areas of high intensity; it was markedly different in bismuth and somewhat different in antimony. Transl. by K.W.

N68-19129*# General Precision, Inc., Little Falls, N. J. Materials Dept.
BEAM ALIGNMENT TECHNIQUES BASED ON THE CURRENT MULTIPLICATION EFFECT IN PHOTOCONDUCTORS Third Summary Technical Progress Report, 15 Nov. 1966–15 Oct. 1967
Frank V. Allan, Robert Carvalho, Cecil B. Ellis, Aryeh H. Samuel, Joseph Scanlon et al 15 Nov. 1967 53 p refs
(Contract NAS12-8)
(NASA-CR-86035) CFSTI: HC $3.00/MF $0.65 CSCL 20L

Work was conducted to develop techniques required for infrared sensitive photoconductors. An ac detection method was developed and utilized in coincident beam experiments with mechanically lapped, single crystal germanium samples. In one experiment there was some evidence of the enhancement effect, but the result was inconclusive. Problems with electrical contact to the germanium surface led to the development of a new method for applying semi-transparent electrodes. It was found necessary to etch the germanium surfaces. A mathematical model was derived and applied to germanium; an enhancement effect was predicted for physically meaningful conditions. An application analysis was also carried out. K.W.

N68-19132* Rocketdyne, Canoga Park, Calif.
APPLICATION OF THE MOSSBAUER EFFECT TO TRANSDUCERS Final Report, 5 Feb. 1965–4 Feb. 1966
W. F. Netusil and E. N. Sosa Feb. 1966 116 p refs
(Contract NAS8-20005)
(NASA-CR-75658; R-6463) CSCL 20L

The Mossbauer theory is presented along with a theoretical treatment of the absorption characteristics found in Mossbauer experiments with Fe^{57}. In order to adapt the Mossbauer effect to vibration measurements, velocity calibration spectra of Co^{57}–Pd source-absorber combinations were obtained. In a partial resonance case with SS 310, Fe^{57} enriched SS 310, and SS 316 absorbers, the calibration spectra proved that the Fe^{57} enriched SS 310 has the most useful characteristics. In an off resonance case, the source-absorber combinations used gave split line resonance absorption curves and the calibration spectra obtained showed a very narrow line width associated with the resonance peaks. The third resonance case uses a source-absorber combination (Pd–Fe foil) which exhibits no chemical shift and maximum resonance at zero velocity. The obtained absorption curve is independent of the frequency used and depends only on the peak velocity of the motion. Vibration inducing transducers were calibrated by these methods and showed good precision and accuracy in measuring displacement amplitudes at high frequencies two orders of magnitude smaller than measured by optical interferometer. G.G.

N68-19140*# Avco-Everett Research Lab., Everett, Mass.
AC LOSSES IN TYPE 2 SUPERCONDUCTORS
Frank Di Salvo Sep. 1966 49 p refs
(Contract NAS8-5279)
(NASA-CR-61654; AMP-206) CFSTI: HC $3.00/MF $0.65 CSCL 20L

Two experiments were set up to determine the AC losses in Type II superconductors, one using electrical methods and the other using calorimetric measurements. In the first experiment, alternating currents up to the quench current were applied to several feet of coiled Nb–Zr wire. The results, measured electrically, showed that: (1) the loss was directly proportional to the frequency; (2) at currents below 4 A rms, the loss is proportional to I^2; (3) at currents above 6 A rms, the loss is proportional to $I^{\approx 3.7}$; and (4) the magnitude of the loss depends sharply on the geometry of the wire configuration. The results lead to the conclusion that the magnetic field at the surface of the wire is the important variable in the determination of losses—not the transport current. In the second experiment, an AC magnetic field was applied to the superconductor (Nb–Zr, Nb–Ti, Nb_3–Sn) and independently transport currents could be applied. The results, as measured calorimetrically, have shown that if the conductor is stabilized, the sample will carry currents to the short sample characteristic. As the transport current increases, the losses increase slightly. The loss due to the transport current is shown to be proportional to I^2. Author

N68-19194 University of Southern Calif., Los Angeles.
ENERGY LOSS OF PROTONS WITH ENERGIES UP TO 30 MEV IN DIFFERENT MATERIALS
Christoph Tschalaer (Ph.D. Thesis) 1967 178 p
Available from Univ. Microfilms: HC $8.20/MF $3.00 Order No. 67-5315

The energy loss of protons in Be, Al, Si, lucite, sapphire, and quartz was measured. The incident energy of 20 MeV was determined by a magnetic spectrometer to 0.1% accuracy. The final energy of 3 MeV to 18 MeV was measured by a Li-drift silicon detector to an accuracy of 24 keV. The straggling distribution and the correction for multiple scattering for the final energy were calculated numerically. The mean excitation potentials I were determined by a least squares fit of the theoretical range function to the experimental data as $I_{Be} = 66.8$ eV, $I_{Al} = 167.0$ eV, $I_{Si} = 173.5$ eV, $I_{lucite} = 74.2$ eV, $I_{sapphire} = 145.2$ eV, and $I_{quartz} = 139.2$ eV. The error of I was ±0.5%. The I-value of sapphire deviates from the one obtained from the Bragg-rule by 11%, the I-value of quartz deviates by 7%. Dissert. Abstr.

N68-19200# Stanford Univ., Calif.
A CRYSTAL FIELD ANALYSIS OF COBALT IMPURITIES IN GaP
Douglas Henry Loescher (Ph.D. Thesis) 1967 72 p
Available from Univ. Microfilms: HC $4.00/MF $3.00 Order No. 67-7945

Crystal field theory has been used to explain the electrical and optical properties of cobalt-doped GaP. In n-type GaP, cobalt gives rise to optical absorption bands at 0.8 and 1.25 microns. From Hall effect data it has been found that cobalt is a deep acceptor with an ionization energy of 0.41 eV. A crystal field analysis has shown that the electron configuration around full cobalt acceptors (negatively charged) consists of seven d-electrons with all other electrons in closed shells, and furthermore, that cobalt atoms have substituted for gallium atoms in the lattice. In general, the analysis has shown that crystal field theory can be used to

obtain detailed electron models of semiconductor impurities. In the course of this study, methods were developed to grow epitaxial single crystals of GaP doped with either sulfur or zinc. Predictable sulfur dopings between 6×10^{16} and 4×10^{18} cm^{-3} were achieved. Dissert. Abstr.

N68-19203 Stanford Univ., Calif.
PHOTOEMISSION STUDIES OF THE ELECTRONIC STRUCUTRE OF CdTe, CdSe, AND CdS
Joseph Leo Shay (Ph.D. Thesis) 1967 163 p
Available from Univ. Microfilms: HC $7.60/MF $3.00 Order No. 67-7969

Photoemission studies are used to determine properties of the electronic structure of CdTe, CdSe, and CdS over an energy range extending from about 10 eV below to 10 eV above the valence band maximum. The features of the photoemission from CdSe and CdS are very similar; however the features of the photoemission from CdTe are quite different from those of CdSe and CdS. The sharp features of the CdTe photoemission data are due to direct transitions. These direct transitions are assigned to specific regions of the Brillouin zone, and several reflectivity peaks are given new assignments. Although there are sharp matrix-element variations in CdSe and CdS, few of these have been positively identified as being due to direct transitions. Using the density of states analysis, we have separated the matrix-element-dependent transitions from those due only to the density of states. Dissert. Abstr.

N68-19216 Yale Univ., New Haven, Conn.
MAGNETIC INTERACTIONS IN RARE EARTH INSULATORS
Robert Joseph Birgeneau (Ph.D. Thesis) 1967 256 p
Available from Univ. Microfilms: HC $11.70/MF $3.30 Order No. 67-6995

Magnetic interactions in rare earth insulators are investigated using as a representative system the rare earth trichlorides. Gd^{3+} ($4f^7-{}^8S_{7/2}$) and Ce^{3+} ($4f^1-{}^2F_{5/2}-Jz=\pm5/2$ lowest) are chosen for detailed study. The main experimental technique employed is the EPR of pairs of these ions doped into the diamagnetic isostructural lattices $LaCl_3$ and $EuCl_3$. Since the exchange is comparable with other terms in the spin Hamiltonian, precise values of the interaction constants may be obtained from the pair microwave resonance fields. The theory of electric quadrupole–quadrupole interaction (EQQ) is considered in detail and then applied to Ce^{3+} pairs in $LaCl_3$. The EQQ coupling coefficient is deduced from the nnn pair spectrum and it is then shown that for the nn and nnn second order EQQ and magnetic dipole coupling alone give a good description of the magnetic interactions and for the more distant neighbors magnetic dipole coupling alone is sufficient. Dissert. Abstr.

N68-19256 Texas Univ., Austin.
AN INVESTIGATION OF THE CRYSTAL CHEMISTRY, MAGNETIC AND ELECTRICAL PROPERTIES OF THE PHASES IN THE Yb–Sb SYSTEM
Raymond Eugene Bodnar (Ph.D. Tehsis) 1967 128 p
Available from Univ. Microfilms: HC $6.20/MF $3.00 Order No. 67-8092

The intermetallic binary system of ytterbium and antimony was investigated and an equilibrium phase diagram is proposed. Seven stable intermediate phases were found to exist with the following probable crystal space groups: $YbSb_2$–Cmcm; YbSb2Fm3m; α–Yb_3Sb_4–$I_m$mm; β–Yb_3Sb_4–Pnma; Yb_4Sb_3–I43d; Yb_3Sb_3–$P_m$cm; Yb_5Sb_2–Pn2a. Four structures have been determined as $YbSb_2$–$ZrSi_2$; YbSb–NaCl; Yb_4Sb_3–Th_3P_4 and Yb_5Sb_3–Mn_5Si_3. While the structures of the remaining phases have not been fully evaluated, preliminary work indicates complex structures with statistical atom occupancy in Yb_5Sb_2 and possibly α–Yb_5–Sb_4. Magnetic susceptibility measurements were made by the Faraday technique in the temperature range 1.80°K to 325°K on all the alloys. The results indicate Yb valence variations between two and three in the different alloys. Electrical resistivity measurements were made by the four probe, D–C current method on sintered polycrystalline specimens. Variable resistivities ranging from metallic ($YbSb_2$:ρ_{RT} = 79 μohm-cm) to semiconducting (Yb_5Sb_2:ρ_{RT} = 0.04 ohm-cm) were observed. Dissert. Abstr.

N68-19291 Texas Univ., Austin.
RESIDUAL SUPERCONDUCTING RF LOSSES
Joe Mayer Victor (Ph.D. Thesis) 1967 122 p
Available from Univ. Microfilms: HC $6.00/MF $3.00 Order No. 67-8168

Theoretical and experimental investigations are made into the residual rf losses at temperatures well below the critical value in superconductors. Pulse techniques are used to measure the superconducting circuit Q, yielding a direct indication of the surface losses. The experimental measurements are made in the frequency range from 60–350 MHz, at temperatures below 4.2°K in tin foil samples. The circuits were cooled in an external magnetic field. The measurements are also restricted to very low level rf fields. Flux trapped during the cooling process is proposed as the rf loss mechanism. Experimental data are shown which support the dependences predicted in the trapped flux model. Temperature measurements for various cooling fields agree with the temperature dependence of the predicted losses and the linear dependence of the losses on the external magnetic field. The loss mechanism is shown to depend upon an annealable property of the material. The experimental results show a resistance independent of current level as predicted by the model. Dissert. Abstr.

N68-19333* Arizona Univ., Tucson. Dept. of Nuclear Engineering.
PHOTOCONDUCTIVITY IN METAL OXIDES IN HIGH GAMMA FIELDS
Monte V. Davis 1966 7 p Presented at the Am. Phys. Soc. Meeting, 31 Aug. 1966 *Its* Paper EH-12
(Grant NGR-03-002-056)
(NASA-CR-77829) CSCL 20L

Consideration is given to determining the photoconductivity of ceramic insulators subjected to a high intensity field of gamma radiation. Slides are given showing the temperature dependence of the conductivity without a radiation field and the conductivity when exposed to a radiation field of approximately 5×10^6 R/hr. Data were also accumulated at specific power between 0 and 6 kilowatts/liter in which conductivity is a function of reactor power with temperature entering as a parameter. To explain the change in conductivity, equations are derived to determine the energy shift of the Fermi level in the different materials tested. B.S.D.

N68-19337# Laboratoire de Physique Theorique et des Hautes Energies, Orsay (France).
GROUND STATE OF SOLID NEON
J. P. Hansen Jan. 1968 16 p refs
(TH-68-1) CFSTI: HC $3.00/MF $0.65

A variational calculation of the ground-state energy versus density curve of solid neon is presented using a two-parameter wave function which takes correlations between pairs of atoms into account. A Monte Carlo method is used for the computation of the energy expectation value, the ground-state pressure and the single-particle distribution function. The Lennard–Jones interatomic potential is assumed throughout and various potential parameter values are discussed. If carefully determined experimental parameters are used, a pressure versus density curve is obtained which is in good agreement with experiment. Author

N68-19342 Philips Gloeilampenfabrieken N. V., Eindhoven (Netherlands).
MAGNETIC PROPERTIES OF SOME FERROXPLANA SINGLE CRYSTALS
J. Verweel 1968 86 p refs *Its* Philips Res. Repts. Suppl. No. 9

Investigations were carried out on single crystal samples of the hexagonal compound $BaZnFe_6O_{11}$(ZnY) and related compositions. The crystals were gorwn by the $BaO-B_2O_3$ flux technique. Some amount of Fe^{11} ions was present in most samples and the analysis of the crystals by the microbeam technique showed the presence of some second-phase inclusions. Some voids could also be detected. The magnetostriction in the basal plane was measured as $7.7 \cdot 10^{-7}$ with a 2ϕ dependence. The shape of the hysteresis loops of small single-crystal toroids at room temperature could be ascribed to crystal imperfections. The crystal anisotropy was measured at room temperature and 77°K by the variation with orientation of the field for ferromagnetic resonance at 9.3 GHz. The influence of a misorientation on the resonance field was calculated. A relation between the Curie temperature and the Fe^{11} content was established. Author

N68-19440# Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires.
CHANNELING APPLIED TO THE STUDY OF DEFECTS [LA CANALISATION APPLIQUEE A L'ETUDE DES DEFAUTS]
Jean Pierre Genthon Nov. 1967 33 p refs In FRENCH
(CEA-BIB-99)

The channeling effects of fast charged particles passing through crystals have been used since 1966 for studying crystal defects. Transmission effects and effects due to change in the amount of short distance reactions together with blocking effects have been used by different authors to measure, to detect, and even to localize different types of defects in the crystal or even in the crystal lattice. This very general and very promising technique should soon be improved beyond the qualitative stage. Author (NSA)

N68-19492*# National Aeronautics and Space Administration, Washington, D. C.
OXYGEN IN SILICON [KISLOROD V KREMNII]
S. S. Surkova Mar. 1968 7 p refs Transl. into ENGLISH from the Publ. "Fizicheskiye Svoystva Osobo Chistykh Metallov i Poluprovodnikov" Fan Press, Tashkent, 1966 p 118–124
(NASA-TT-F-11556) CFSTI: HC $3.00/MF $0.65 CSCL 20L

Survey of current methods for determining the oxygen concentration in silicon semiconductors. Various properties of oxygen are discussed in view of the lack of electrical effects in oxygen impurities. The formation of compounds exhibiting donor properties at certain temperatures during heat treating is considered, together with the effects of oxygen on carrier lifetime, surface etching, and dislocations. A method involving the measurement of absorption in the 9.1-μ range to determine oxygen content is described in detail. Author

27 PROPELLANTS

Includes fuels; igniters; and oxidizers. For basic research see: 06 Chemistry; and 33 Thermodynamics and Combustion. For related information see also: 28 Propulsion Systems.

N68-18305# Aerospace Corp., El Segundo, Calif. Lab. Operations.
STUDIES OF CORROSION INHIBITORS FOR NITROGEN TETROXIDE, MAY 1964–JUNE 1967
Frank D. Hess Sep. 1967 34 p refs
(Contract F04695-67-C-0158)
(TR-0158(3210-10)-4; SAMSO-TR-67-130; AD-664058)

An investigation was made of gross surface corrosion of magnesium, aluminum, stainless steel, and titanium in nitrogen tetroxide containing added water. Various corrosion inhibitors were tried in this system, and five of these were found to have some effect in reducing corrosion. They are phosphorus trifluoride, phosphorus pentafluoride, ammonium fluorosulfonate, potassium fluorosulfonate, and tetramethylammonium tetrafluoroborate. Author (TAB)

N68-18382# Office of Naval Research, Washington, D. C.
THE SAFE HANDLING OF HIGH-ENERGY LIQUIDS: SOME PRELIMINARY CONSIDERATIONS
20 Mar. 1967 3 p
(AD-664254)

Some of the characteristics of low velocity detonations are summarized, and methods of minimizing the risk of such detonations when handling high-energy liquid chemical systems are outlined. TAB

N68-18436# Aerojet-General Corp., Sacramento, Calif.
DEVELOPMENT OF CRITERIA FOR SOLID PROPELLANT SCREENING AND PRELIMINARY ENGINEERING DESIGN. AN APPLICATION OF CUMULATIVE DAMAGE CONCEPTS Quarterly Report, 9 Sep.–8 Dec. 1967
Kenneth W. Bills, Jr. Dec. 1967 105 p refs
(Contract N00017-67-C-2415)
(Rept.-1159-81Q-2; QR-2; AD-664514)

Available cumulative damage concepts take into account the past stress and temperature histories. However, the procedures as they now stand are not convenient for use in propellant screening nor preliminary grain design. This program is designed to produce the needed criteria. Both the engineering analyses and the cumulative damage relations are available for much of this work, but some areas need further development. These areas will be studied analytically and experimentally using model test specimens and test motors. Concurrently, design parameters for specific modes of motor usage can be generated from existing relationships. Since the cumulative damage parameters for solid propellants are readily available from uniaxial tensile data it should be possible, in principle, to devise straightforward, easily obtainable performance criteria. Taken together they should lead to the desired criteria needed to guide preliminary engineering design and the selection of optimum propellant formulations. This report gives the current status of all the planned activities. Author (TAB)

N68-19010*# Thiokol Chemical Corp., Denville, N. J. Reaction Motors Div.
GELLING OF CRYOGENIC OXIDIZERS Final Report, 5 May 1965–4 Sep. 1966
A. J. Beardell and R. Gere 19 Feb. 1968 59 p refs
(Contract NAS3-6286)
(NASA-CR-72152; RMD-5070-F) CFSTI: HC $3.00/MF $0.65 CSCL 21I

A freeze dry method was developed for the preparation of ultrafine particle size lithium fluoride. The ultrafine material, in the form of rods having approximately a length of 0.4μ and a width of 0.04μ, will thicken OF_2 but not liquid F_2. The liquid OF_2–LiF gel is both thermally stable and shock insensitive but is not stable under flow conditions. Liquid OF_2–Cab-O-Sil gels were prepared in quantities of up to 1 lb. The gels were examined rheologically and mechanical stability tests, slosh tests and boiloff rates were measured. Pressure drops of 1 to 12 psi were produced across a capillary tube and apparent viscosities of 0.21 to 7.16 poise were measured. The OF_2–Cab-O-Sil gel behaved satisfactorily

in slosh tests but boiloff rates and inverted tube tests gave inconclusive results. Author

N68-19268*# Bureau of Mines, Pittsburgh, Pa. Explosives Research Center.
EXPLORATORY STUDY OF HYPERGOLIC IGNITION SPIKE PHENOMENA, PHASE 2, PART 2, JULY 1 TO SEPTEMBER 30, 1966
Theodore Christos, Yael Miron, Harry James, and Henry E. Perlee 30 Sep. 1966 30 p refs
(NASA Order T-39882(G))
(NASA-CR-93556) CFSTI: HC$3.00/MF$0.65 CSCL 21B

The physical and combustion characteristics of hydrazine nitrate (HN) are examined, and the results from a chemical analysis of the residue from test firings of Aerozine-50/nitrogen tetroxide 100-thrust engines are reported. Among the physical properties considered are solubility of HN in water and in hydrazine, the density HN-hydrazine and HN-water solutions, viscosity of HN-water solutions, and rate of vaporization. The combustion characteristics of HN evaluated include combustion temperature, gap-sensitivity, detonation velocity, and the determination of HN material that would support a detonation in the form of a thin film. From results of these studies it is possible to estimate thickness and flow of the residue films in these engines during periods of operation, maximum amounts of residue that accumulates during any pulse sequence, and when the residues have the proper hydrazine nitrate content to constitute a detonable mixture. It is concluded that hydrazine nitrate is a major constituent of these engine residues and that its combustion characteristics classify it as a potential contributor to the ignition spike phenomena. B.S.D.

N68-19466*# Atlantic Research Corp., Alexandria, Va.
DETERMINATION OF THERMODYNAMIC PROPERTIES OF AEROZINE-50, PHASE 1
Joseph P. Copeland, John A. Simmons, and Jack M. Spurlock 21 Apr. 1967 45 p refs
(Contract NAS9-6720)
(NASA-CR-65995) CFSTI: HC$3.00/MF$0.65 CSCL 21H

This report describes the results of the first phase of a program to determine the thermodynamic properties of the propellant, Aerozine-50 (A 1:1 mixture of hydrazine and UDMH), which are to be presented in useful charts and tables showing the corresponding values of enthalpy, entropy, phase composition, pressure, temperature and specific volume. The first phase of the program has included (1) a survey and evaluation of pertinent data reported in the literature, (2) selection of the most appropriate methods of correlating the data and calculating values of the thermodynamic properties, (3) determination of what data is lacking or unreliable, and must be measured, (4) delineation of the experiments and techniques to accomplish this, and (5) selection of the most appropriate means to present the derived thermodynamic properties. Author

28 PROPULSION SYSTEMS

Includes air breathing, electric, liquid, solid, and magneto-hydrodynamic propulsion. For nuclear propulsion see: 22 Nuclear Engineering. For basic research see: 23 Physics, General; and 33 Thermodynamics and Combustion. For applications see: 31 Space Vehicles. For related information see also: 27 Propellants.

N68-18320# Adelaide Univ. (Australia). Dept. of Mechanical Engineering.
HYDROJET DUCTED PROPULSION SYSTEM: IMPELLER INDUCED VIBRATORY PRESSURES AND PERFORMANCE CHARACTERISTICS Final Report, 1 Sep. 1964–30 Nov. 1966
Malcolm R. Hale and Douglas H. Norrie Nov. 1966 160 p refs
(Contract Nonr-4738(00)(X))
(R66/3; AD-664518) CFSTI: HC$3.00/MF$0.65

A vortex-line theory developed for an impeller in a long duct was used to optimize the design of a Hydrojet impeller. A model Hydrojet with this impeller was instrumented for pressure field and impeller performance measurements. Fluctuating pressures were high near impeller but attenuate to <10% at 0.4D. 1st/2nd/3rd blade frequency harmonics were approximately in ratio of 1.0/0.6/0.25. 0.85 - 0.90 impeller efficiency appears possible. Author (TAB)

N68-18547# Rocketdyne, Canoga Park, Calif.
EXPERIMENTAL GAS TURBINE ENGINE STARTER Interim Report, 17 Feb.–16 Aug. 1967
L. E. Fuller and J. P. Maddox 12 Sep. 1967 16 p refs
(Contract DAAK02-67-C-0180)
(R-7217; AD-664230)

Progress in a program to develop a compact, light weight, experimental gas turbine starter is presented. The starter being developed consists of a gas producer, a turbine, and fuel and air and ignition controls. The gas producer is a unique resonant combustor with multiple spiral tail pipes supplying intermittent hot-gas jets that impinge on the turbine blades. Work covered during Phase I of the program includes breadboard experiments, analysis, design of a prototype system, and prototype gas producer checkout tests. Results of tests are compared with design objectives and are used to calculate predicted performance of the prototype. TAB

N68-18678# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ANALYSIS OF THE WORK OF A TURBOJET ENGINE WITH THRUST REVERSAL BY THE METHOD OF SMALL DEVIATIONS [ANALIZ RABOTY TRD S REVERSOM TYAGI METODOM MALYKH OTKLONENIY]
A. S. Tikhonov *In its* News of Inst. of Higher Learning. Aeron. Eng. 10 Apr. 1967 p 91–100 refs (See N68-18668 09-23)

Thrust reversers mounted on turbojet engines effect the engine operating parameters during thrust reversal and application of forward thrust. The maintenance of constant operating parameters is of particular importance in transient regimes when the thrust reversers are engaged or disengaged. Therefore, an analysis by the method of small deviations was made to establish relationships between the engine operating parameters (compressor speed and gas temperature) and the thrust reverser parameters and to determine the change in the magnitude of the reverse thrust as a function of the operating parameters. Author

N68-18686# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
EXPERIMENTAL INVESTIGATIONS OF A FUEL EVAPORATOR [EKSPERIMENTAL'NYYE ISSLEDOVANIYA TOPLIVNOGO ISPARITELYA]
I. N. Dyatlov *In its* News of Inst. of Higher Learning. Aeron. Eng. 10 Apr. 1967 p 145–151 refs (See N68-18668 09-23)

Two types of fuel evaporators, one a dismountable, vertical-tube evaporator and the other a coil-type evaporator, were constructed and tested to verify methods previously developed by the author for calculating the heat transfer surface. In both designs, the fuel (T-1 kerosine) flowed inside the pipes, and the hot gas, outside. Tests were made at hot-gas temperatures of 705° and 635°C, gas flow velocities of 195–264 m/sec, and fuel flow rates of 50–250 kg/hr. The experimental and calculated heat transfer surface areas (within a range of 0.02 m^2) were in good agreement. Author

N68-18714# Pratt and Whitney Aircraft, West Palm Beach, Fla. Florida Research and Development Center.
DESIGN AND EVALUATION OF A HIGH TEMPERATURE RADIAL TURBINE Quarterly Technical Progress Report, 18 Jul.–31 Oct. 1967
G. S. Calvert 13 Nov. 1967 49 p
(Contract DAAJ02-68-C-0003)
(PWA-FR-2631A; QTPR-1; AD-664236)

Radial turbines offer greater stage work capacity than axial turbines. If this advantage can be coupled with a capability of accommodating high turbine inlet temperatures, radial turbines will permit appreciable simplification of small gas turbine engines for use in future Army vehicles. The objective of the contract is to develop a technology for high temperature radial turbines to a level that will permit a potential small-engine manufacturer to make a choice between the radial and axial turbine. A two-year, two-phase program is being conducted involving the design and testing of a cooled, single-stage, radial-inflow turbine with the following design conditions: 2300F turbine inlet temperature, total-to-total aerodynamic efficiency of 87.5%, gas flow of 5 lb/sec, and stage work parameter of 42.5 Btu/lb. The first phase of the program involves a preliminary design of the cooled radial turbine, including development of cold flow data to permit design optimization. Author (TAB)

N68-18739# Hamilton Standard Div., United Aircraft Corp., Windsor Locks, Conn.
ASSURING RELIABILITY IN JET FUEL CONTROLS
Robert [illegible] 9 Nov. 1967 9 p Presented at FAA Maintenance Symp., Oklahoma City, 7–9 Nov. 1967
(AD-664[illegible]; CFSTI: HC $3.00/MF $0.65

The paper demonstrates the effort made to engineer a high level of reliability in a new jet fuel control and thereafter, vigorously pursue programs to maintain and improve the original design reliability level. The Overhaul and Repair Department is a major factor in this process. Author (TAB)

N68-18820*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
EXPERIMENTAL PERFORMANCE OF A LOW-THRUST, DIVERGENT-FLOW, CONTACT-IONIZATION ELECTROSTATIC THRUSTOR
John F. Staggs and Walter C. Lathem Washington 1966 26 p refs Presented at the 2d Propulsion Joint Specialist Conf., Colorado Springs, 13–17 Jun. 1966
(NASA-TM-X-52194) CFSTI: HC $3.00/MF $0.65 CSCL 21C

An experimental electrostatic ion thrustor employing cesium on tungsten contact-ionization is described that has promise of meeting the approximate requirements for certain satellite attitude control and station keeping missions. The basic configuration presented is derived from the concept of divergent flow between coaxial cylinders. The ionizer emitting area is 1.0 cm^2 (1.52 mm chord length by 6.35 cm long). The radius of the convex emitting surface is 3.0 mm. Power efficiencies of 45% (excluding vaporizer and neutralizer powers) have been achieved at thrust levels of approximately 1.56 mN (0.35 mlb) and specific impulses near 700 s. Typical accelerator drain currents are on the order of 2% of the beam current or less. Numerical analysis of possible electrode erosion due to charge exchange indicates that an electrode lifetime in excess of 20,000 hrs should be obtainable. Author

N68-18971* LTV Aerospace Corp., Dallas, Tex. Missiles and Space Div.
FEASIBILITY STUDY FOR A 44-INCH FIRST STAGE ROCKET MOTOR Final Report
31 Aug. 1967 371 p refs
(Contract NAS1-6935; Proj. Scout)
(NASA-CR-66545; Rept.-23.325) CFSTI: $3.00 CSCL 21H

Details are given on a feasibility study to evaluate the increase in capabilities of the Scout vehicle with a 44 inch first stage motor and to evaluate the changes to the basic vehicle and to the operational ground support equipment that result from the larger and greater weight first stage motor. Results are presented on various phases of the study which include structural analysis, thermodynamics, loads and dynamics, solid propulsion, flight dynamics, guidance and controls, and flight mechanics. Details are also given on vehicle design and ground support equipment. Based upon wind tunnel testing, it is concluded that a 44 inch first stage rocket motor can be utilized on the current Scout system with no minor modifications to the basic vehicle and small changes to the ground support equipment. B.S.D.

N68-18974*# Pratt and Whitney Aircraft, West Palm Beach, Fla. Research and Development Center.
DEVELOPMENT OF A SHORT-LENGTH TURBOJET COMBUSTOR Summary Report, 3 Jun. 1965–18 Apr. 1967
D. L. Kitts 18 Mar. 1968 302 p
(Contract NAS3-7905)
(NASA-CR-54560; PWA-FR-2433) CFSTI: HC $3.00/MF $0.65 CSCL 21E

An experimental study was conducted using a quarter sector of a full-scale gas turbine combustor with an outer diameter of 40 inches and a combustion length of 12 inches. Two twin annulus combustor design, providing either atomized or vaporized injection of ASTM-A1 fuel, were tested. Performance data were obtained for a range of operating conditions including simulated Mach 3 cruise at an altitude of 65,000 feet, with a combustor outlet temperature of 2200°F. Acceptable values for combustion efficiency and total pressure loss were measured in both combustors; however further improvements in combustor outlet temperature profile are required in both combustors. Author

N68-19048*# Rocketdyne, Canoga Park, Calif.
THERMODYNAMIC IMPROVEMENTS IN LIQUID HYDROGEN TURBOPUMPS Interim Report, 17 Jun. 1966–17 Jun. 1967
G. S. Wong and W. R. Wagner Jul. 1967 327 p refs
(Contract NAS8-20324)
(NASA-CR-93540; R-7138) CFSTI: HC $3.00/MF $0.65 CSCL 21H

Analytical and experimental results are presented of an investigation to develop engineering criteria to improve liquid hydrogen turbopumps for rocket engines. Alleviating the constraints of extensive pump thermal preconditioning and a narrow starting region envelope were of particular interest. Pump and turbine aspects associated with start, shutdown, coast, and restart were delineated. Nondimensional parameter and rating groups were established, and thrust scaling approaches with proportionalities are provided. The assumed thrust base is representative of H_2/O_2-fueled engine systems; application to nuclear and H_2/O_2-propelled engine systems is therefore possible by simple flow rate conversion. The study covers the following four tasks: (1) pump thermal design; (2) materials; (3) pump preconditioning and thermal protection; and (4) analysis of existing turbopumps. K.W.

N68-19070*# Pratt and Whitney Aircraft, West Palm Beach, Fla. Research and Development Center.
FULL SCALE TURBOFAN DUCT BURNER TEST PROGRAM Final Report, 29 Jun. 1965–30 Jun. 1967
C. J. Clapp 18 Mar. 1968 260 p
(Contract NAS3-7907)
(NASA-CR-54637; PWA-FR-2542) CFSTI: HC $3.00/MF $0.65 CSCL 21E

The objective of the effort described in this report was to investigate the performance and structural durability of a full-scale

turbofan duct burner operating at conditions typical of advanced supersonic aircraft. A full-scale duct burner of the ram-induction type having an outer casing diameter of 67.7 inches and an inner casing diameter of 47 inches was tested. The burner inlet and outlet flow passages had the size and shape of an advanced turbofan engine design rated for 600 lb/sec at sea level static conditions. Good structural durability of the final ram-induction burner design was demonstrated. Performance data were obtained for a range of operating conditions including climb and simulated Mach 2.7 at an altitude of 70,000 ft. The final configuration tested had an isothermal total pressure loss of 5% and achieved combustion efficiencies greater than 90% over the range of conditions tested. The occurrence of combustion instability at some test points prevented covering the entire operating range with a single configuration and fuel flow mode. Author

N68-19074# Swedish State Shipbuilding Experimental Tank, Goteborg.

WAKE AND THRUST DEDUCTION AT EXTREME PROPELLER LOADINGS

Sv. Aa. Harvald 1967 51 p refs *Its* Publ. No. 61

CFSTI: HC $3.00/MF $0.65

Wake and thrust deduction have been determined by tests with models of a fishing trawler and a bulk carrier. The experiments have been carried out at several different speeds, both ahead and astern, and with various revolutions. The following combinations have been studied: (1) ship going ahead, propeller going ahead; (2) ship going astern, propeller goin going ahead; (3) ship going ahead, propeller going astern; (4) ship going astern, propeller going astern. The trawler model was tested with 2 different propellers. Propeller diagrams have been prepared giving the thrust coefficient, the torque coefficient, and resistance + tow rope pull coefficient as functions of the advance numbers for all these combination. Furthermore, the wake coefficient and the thrust deduction coefficient have been shown as functions of the advance number. Finally, maneuver nomograms for the two models have also been prepared. Author

N68-19123*# Rocketdyne, Canoga Park, Calif.

PERFORMANCE ANALYSIS OF COMPOSITE PROPULSION SYSTEMS, PHASE 1 Final Report, 30 Dec. 1966–29 Dec. 1967

J. A. Wrubel Jan. 1968 55 p refs

(Contract NAS7-521)

(NASA-CR-93548; R-7346) CFSTI: HC $3.00/MF $0.65 CSCL 21H

The flow field and turbulent transport properties in gas stream turbulent mixing are the subject of this study. Described is the initial phase of hardware design and flow facility construction, for the experimental investigation of two-dimensional mixing of supersonic hydrogen-oxygen combustion products and a subsonic air stream. The mixing will be accomplished in a chamber accessible to both optical- and probe-type instrumentation systems. Author

N68-19148# Swedish State Shipbuilding Experimental Tank, Goteborg.

A METHOD FOR THE DESIGN OF DUCTED PROPELLERS IN A UNIFORM FLOW

Gilbert Dyne 1967 54 p refs *Its* Publ. No. 62

CFSTI: HC $3.00/MF $0.65

Design calculations for ducted propellers in uniform flow fields replaced the actual propeller by an equivalent infinite-bladed propeller represented by continuous radial distributions of ring vortices and rectilinear vortices; the duct is replaced by a source sink system and the hub is replaced by a source distribution along the axis. The definite strengths of the vortex systems is then determined by iteration so that the desired total thrust can be calculated according to the momentum theorem. The shape of the duct is obtained from axial velocities. Due to the relatively great blade widths generally used for ship propellers, the axial variation of the induced velocities make camber and pitch corrections necessary. Preliminary results from experiments carried out indicate good agreement between the experimental and calculated values of total thrust, duct thrust, and propeller efficiency. G.G.

N68-19360*# Hughes Aircraft Co., El Segundo, Calif. Space Systems Div.

[ANALYTICAL AND EXPERIMENTAL INVESTIGATIONS CONCERNING THE DUAL MODE HYDRAZINE SYSTEM, TASK 4] Summary Report, 1 Aug. 1967–1 Feb. 1968

W. H. Jones, W. W. Butcher, and R. M. Lodwig 1 Mar. 1968 68 p refs Prepared for JPL

(Contracts NAS7-100; JPL-951720)

(NASA-CR-93663; Rept.-68(22)-2749/B1183-002) CFSTI: HC $3.00/MF $0.65 CSCL 21H

Analytical and experimental investigations are reported concerning the Dual Mode Hydrazine System for attitude control and maneuvering propulsion of an advanced interplanetary space probe. The fundamentals of hydrazine electrolysis, including stoichiometry, electrolyte and electrode properties, materials compatibilities, power requirements, and reaction controllability are included. In addition, the problems of zero-g operation are considered. It is concluded that there are no fundamental obstacles to construction and test of a developmental model hydrazine electrolysis assembly; materials and a preliminary design are selected. Author

N68-19439*# TRW Systems, Redondo Beach, Calif.

PRODUCING HOLOGRAMS OF REACTING SPRAYS IN LIQUID PROPELLANT ROCKET ENGINES, PHASE 1 Interim Report, 1 Aug. 1967–7 Feb. 1968

R. F. Wuerker and B. J. Matthews 29 Feb. 1968 64 p refs Prepared for JPL

(Contracts NAS7-100; JPL-952023)

(NASA-CR-93662; TRW-68-4712-2-017) CFSTI: HC $3.00/MF $0.65 CSCL 21H

A program was conducted to demonstrate the feasibility of producing pulsed ruby laser holograms of reacting sprays. Efforts to produce holograms of open flame combustion generated by a single unlike doublet injector element resulted in the design of a unique two beam laser illuminated holocamera which was constructed and demonstrated. The first holograms ever produced of reacting liquid propellant sprays were recorded with this holocamera during open flame test firings. A description of the design and development of the holographic test apparatus is presented along with the cold flow and open flame test holograms. Laser illuminated photographic experiments were also conducted and the results of these tests and representative photographs are included. R.N.A.

N68-19448*# Mathematical Applications Group, Inc., White Plains, N. Y.

NONLINEAR COMBUSTION INSTABILITY IN LIQUID PROPELLANT ROCKET MOTORS

Samuel Z. Burstein and Wallace Chinitz 30 Jan. 1968 69 p refs Prepared for JPL

(Contracts NAS7-100; JPL-951946)

(NASA-CR-93674; QR-2) CFSTI: HC $3.00/MF $0.65 CSCL 21B

The theory of finite rate processes in the combustion of hydrazine/nitrogen tetroxide is discussed, and the method for obtaining the equilibrium species concentrations is detailed. The diffusion-controlled flame analysis was coupled to the basic computer program, COMB, and the results are compared with previously

obtained data. The fluid dynamic model is considered, and a method is described for computing the solution to the partial differential equations of a compressible fluid in cylindrical coordinates in the neighborhood of the singular point. Also described are the results of some time-dependent computations in which a finite amplitude pressure wave is allowed to rotate and steepen in a cylindrical chamber. M.G.J.

29 SPACE RADIATION

Includes cosmic radiation; solar flares; solar radiation; and Van Allen radiation belts. For related information see also: 13 Geophysics; and 24 Physics, Atomic, Molecular, and Nuclear.

N68-18422# Boeing Scientific Research Labs., Seattle, Wash. Geo-Astrophysics Lab.

TRANSPORT OF COSMIC RAYS IN THE INTERPLANETARY MEDIUM

E. C. Roelof. Oct. 1967. 15 p. refs. Presented at the 10th Intern. Conf. on Cosmic Rays, Calgary, Can., 1967

(D1-82-0625; AD-664092)

By quasilinearization of the Liouville equation for a charged particle in an electromagnetic field combined with an ensemble average over field configurations, a transport equation is derived for the ensemble average particle-distribution function. The resulting integro-differential equation is rewritten in terms of a simpler characteristic function which, when found, gives the complete solution in terms of the particle orbits in the ensemble mean fields. With the appropriate approximations, the equation reduces to the Fokker-Planck form applied recently by Jokipii to galactic cosmic-ray modulation, and by the author to energetic solar-flare particle propagation. It is argued that the equation, although complicated, offers several advantages as a starting point for transport theory over the simpler but less appropriate Fokker-Planck and Boltzmann equations. Author (TAB)

N68-18524# Uppsala Univ. (Sweden). Cosmic Ray Group.

COSMIC RAY INTENSITY VARIATIONS DURING 1966

Arne E. Sandstroem, Eric Dyring, Ove Larfors, Stig Lindgren, Bert Sporre et al. 25 Sep. 1967. 35 p. refs

(Contract AF 61(052)-868)

(SN-4; AFCRL-68-0016; AD-664341) CFSTI: HC $3.00/MF $0.65

The recorders have continued as during the last years by one neutron monitor, one cubical telescope and four inclined telescopes in Uppsala and Kiruna. Tables and figures give a detailed account of diurnal and semidiurnal variations during 1966. Six decreases are illustrated in one-hour diagrams. Author (TAB)

N68-18552*# California Univ., Berkeley. Space Sciences Lab.

THE INTERPLANETARY MAGNETIC FIELD: SOLAR ORIGIN AND TERRESTRIAL EFFECTS

John M. Wilcox. 8 Jan. 1968. 139 p. refs. *Its* Ser. No. 9, Issue No. 2

(Grants NsG-243; NGR-05-003-230; Contract Nonr-3656(26))

(NASA-CR-93369; AD-664509) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Many observations related to the large-scale structure of the interplanetary magnetic field, its solar origin and terrestrial effects are discussed. During the period observed by spacecraft the interplanetary field was dominated by a sector structure corotating with the sun in which the field is predominantly away from the sun (on the average in the Archimedes spiral direction) for several days (as observed near the earth), and then toward the sun for several days, etc. The average sector appears to be a coherent entity with internal structure such that its preceding portion is more active than its following portion. Cosmic rays corotate with the interplanetary field, and there are differential flows associated with the sector pattern. Profound effects on geomagnetic activity and the radiation belts are produced as the sector pattern rotates past the earth. The solar origin of the sector pattern is discussed. The solar source may be associated with the large-scale weak background photospheric fields observed with the solar magnetograph. It is suggested that there may be a rather continual relation between this solar structure and terrestrial responses, of which the recurring M-Region geomagnetic storms are just the most prominent example. Author (TAB)

N68-18900# Hughes Aircraft Co., Los Angeles, Calif. Space Systems Div.

AN EXPERIMENTAL TECHNIQUE FOR MEASURING LOCAL SOLAR IRRADIATION WITH A MODEL SPACECRAFT

R. P. Bobco. Dec. 1967. 14 p. refs

(SSD-70530R; Rept.-27)

An experimental process is described which is capable of yielding quantitative information on the local solar exposure of spacecraft models. The technique uses models which are geometrically and reflectively similar to some prototype of interest and tests them in a shirtsleeve environment. In addition to the model, the process requires a collimated radiant field which simulates the solar spectrum, a diffusely reflecting target which is small relative to any model surface, a remote radiation detector with a narrow field of view, and a fixture for holding the model in some desired orientation relative to the radiant source. The experimental method does not require any knowledge of shape factors, solar incidence factors, bidirectional reflectances, or interreflection coefficients. An analytically tractable model was tested using the sun as the radiant source and a photometer as a detector. A comparison between analytical predictions and experimental results indicates that local solar irradiation on a model may be measured with an accuracy that is comparable to the measurement of surface reflectance. The ease and accuracy of the process recommend its use as an engineering thermal design tool. Author

N68-19136*# National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York.

SOLAR SPIN DOWN AND NEUTRINO FLUXES

Dilhan Ezer and A. G. W. Cameron (Yeshiva Univ.). Mar. 1968. 9 p. refs

(NASA-TM-X-60923) CFSTI: HC $3.00/MF $0.65 CSCL 20H

We suggest that the failure of Davis to detect a flux of B^8 neutrinos from the sun may result from the maintainance of a high central hydrogen abundance. This could arise from the circulation currents associated with the spin-down of a fast rotating core. On this basis we predict a lower limit to the flux which is about the same as Davis' upper limit. Author

N68-19188*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

CALCULATIONS OF SOLAR PLASMA INTERACTION WITH MAGNETIC FIELD OF CURRENT LOOP AND TWO PARALLEL INFINITE LINES OF CURRENT

Daniel J. McKinzie, Jr. and Anthony L. Julius, Jr. Washington. Mar. 1968. 28 p. refs

(NASA-TN-D-4304) CFSTI: HC $3.00/MF $0.65 CSCL 03B

An investigation was made of the forces resulting from the interaction of the unconfined magnetic field emanating from a space vehicle with the undisturbed solar wind. The integrated theoretical drag per unit area and the acceleration of a circular

current loop exposed to the solar wind at zero degree angle of incidence were determined. Also, the integrated theoretical drag and lift per unit area, the restoring moment per unit area per unit length of span were determined for the case of two parallel infinite lines of current at a 45° angle of incidence. For the case of the current loop, the drag per unit area varied over a range of proton number densities from 10^6 to 10^8 particles per cubic meter and a magnetic field parameter from 10^{-4} to 10^{-2} tesla. An examination of the particle fluxes from a major solar flare showed it to have a negligible effect on the drag when compared with that from the solar wind. Accelerations were calculated for a hypothetical superconducting coil (hollow torus) that had a permanent unconfined magnetic field. For the case of the two parallel infinite lines of current at a 45° angle of incidence, the lift to drag ratio was approximately 1 to 6.8. Author

N68-19397*# Volt Technical Corp., Washington, D. C.
X-RADIATION OF THE MOON AND ROENTGEN COSMIC BACKGROUND ACCORDING TO DATA OF AMS "LUNA-12" [RENTGENOVSKOYE IZLUCHENIYE LUNY I RENTGENOVSKIY KOSMICHESKIY FON PO DANNYM SPUTNIKA LUNY "LUNA-12"]
S. L. Mandel'shtam, I. P. Tindo, G. S. Cheremukhin, L. S. Sorokin, and A. B. Dmitriyev. 25 Mar. 1968. 11 p. refs. Transl. into ENGLISH from Kosmich. Issled. (Moscow), v. 6, no. 1, 1968 p. 119–127
(Contract NAS5-12487)
(NASA-CR-93658; ST-LPS-RAD-10689) CFSTI: HC $3.00/MF $0.65 CSCL 03B

The results of measurements are presented of soft X-radiation of the Moon probably occurring during fluorescence of the lunar surface under the action of Sun's X-radiation. The flux of Moon's X-radiation in the 8–14 A spectral region constituted in different time periods ≈10–150 photons/cm^2 sec sterad. The cosmic roentgen background constituted ≈7.5 photons cm^2/sec sterad kev in the spectral region 8–12 A. Corpuscular fluxes, apparently electrons of solar origin with energy E>50 kev and reaching ≈1.10^3 particles cm sec sterad, were registered near the Moon. The intensity of these fluxes agrees well with the index A_p of geomagnetic disturbance. Author

N68-19450*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
TABLE OF OUTSTANDING SOLAR-TERRESTRIAL EVENTS IN 1954 THROUGH 1967
Yukio Hakura. Feb. 1968. 7 p. ref.
(NASA-TM-X-63120; X-641-68-62) CFSTI: HC $3.00/MF $0.65 CSCL 03B

In the tabulated data presented, solar flares, solar radio outbursts of type 4, polar cap absorptions, and geomagnetic storms are included. Author

N68-19453*# Volt Technical Corp., Washington, D. C.
OBSERVATIONS AND INTERPRETATION OF ULTRAVIOLET EMISSION FROM THE GALAXY [NABLYUDENIYA I INTERPRETATSIYA ULTRAFIOLETOVOGO IZLUCHENIYA GALAKTIKI]
V. G. Kurt and R. A. Syunyayev. 20 Mar. 1968. 8 p. refs. Transl. into ENGLISH from Astron. Zh. (USSR), v. 44, no. 6, 1967 p. 1157–1161
(Contract NAS5-12487)
(NASA-CR-93659; ST-IGA-10690) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Measurements carried out aboard AIS "VENERA-2" and "VENERA-3" have shown the presence of emission in the 1225–1340 A band and in the L_α-line in the direction toward the Milky Way. Measurements in the above band are explained by the aggregate emission of Galaxy stars and give for luminosity ratio the value $F_\lambda(1300)/F_\lambda(5560) = 1.5 \cdot 10^{-2}$. Taking into account the interstellar absorption it is shown that the ratio of volumetric luminosities of stars of plane component is $j_\lambda(1300)/j_\lambda(5560) = 4 \cdot 10^{-2}$ instead of the computed value 5.9. The upper limit is obtained of Galaxy luminosity in the ultraviolet band (1225–1340 A), which is 2.10^{40} ergs sec. It is shown that the background of extragalactic nebulae in the ultraviolet does not exceed 10^{-24} erg-cm^{-2}-sec-sterad-hz. The emission in L_α possibly is not of galactic origin for because of absorption on dust, the well known sources of L_α-emission in the Galaxy cannot assure the observed flux. An explanation of observations is offered by re-emission of solar L_α-quanta on hydrogen of the interplanetary medium. The necessary increase of plasma density to that of the Milky Way may be connected with the regular galactic magnetic field. Author

30 SPACE SCIENCES

Includes astronomy and astrophysics; cosmology; lunar and planetary flight and exploration; and theoretical analysis of orbit and trajectory. For related information see also: 11 Facilities, Research and Support; and 31 Space Vehicles.

N68-18258# Aerospace Corp., El Segundo, Calif.
DUAL REACTION WHEEL CONTROL OF SPACECRAFT POINTING
Richard M. Terasaki. Nov. 1967. 14 p.
(Contract F04695-67-C-0158)
(TR-0158(3307-01)-2; SAMSO-TR-68-18; AD-664327)

A method of spacecraft pointing control by the use of two body-fixed reaction wheels is proposed, and the development of an appropriate set of control laws, design relationships, and a performance analysis of a sample design are presented. One reaction wheel, designated as primary, is to spin at a nominal, non-zero constant speed and, by itself, is a basis for a momentum bias or spin-despin type of attitude stabilization. A second wheel is mounted in the spacecraft so that its spin axis is perpendicular to that of the primary wheel. The inclusion of the second wheel and control of its speed enhances the spin-despin control system capabilities in two respects: (1) provision for precise attitude maneuverability, and (2) rapid damping of nutation. Author (TAB)

N68-18264# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.
A SIX-DEGREE-OF-FREEDOM DIGITAL COMPUTER PROGRAM FOR TRAJECTORY SIMULATION
Louis D. Duncan and Bernard F. Engebos. Oct. 1967. 74 p. refs.
(ECOM-5158; AD-664116)

A documentation of a six-degree-of-freedom model for digital simulation of the trajectory of an unguided, fin-stabilized, wind-sensitive rocket is presented. This model was developed by the Atmospheric Sciences Laboratory, White Sands Missile Range, New Mexico, to study both theoretical and empirical performance characteristics of unguided rockets. The basic equations of motion and their mathematical formulation for this model are presented without derivation. A general flow chart, a listing of the program, a list of the principal flads used, and a listing of a typical input data deck are included. Author (TAB)

N68-18381*# Bellcomm, Inc., Washington, D. C.
NUMBER DENSITY OF MARTIAN CRATERS
A. H. Marcus. 29 Jan. 1968. 20 p. refs.
(Contract NASw-417)
(NASA-CR-93407; TR-68-710-1) CFSTI: HC $3.00/MF $0.65 CSCL 22A

The author has measured diameters of craters on the A.C.I.C. Cartographic Reduction of Frames 3-14 of the Mariner IV photographs of Mars. The incremental frequency distribution of diameters of craters larger than 20-30 km follows an inverse square law with density equal to that of craters on the lunar continents. This is in accord with the prediction that lunar continents and the Martian surface carry an "equilibrium" density of craters of meteoroidal impact origin. Details of fluctuations in crater counts support this conclusion. Author

N68-18435# Army Dept., Washington, D. C.
GENERAL PERTURBATIONS OF THE ELEMENTS OF ARTIFICIAL LUNAR SATELLITES [ABSOLYUTNYYE VOZMUSCHENIYA ELEMENTOV ISKUSSTVENNYKH SPUTNIKOV LUNY]
V. A. Brumberg 22 Nov. 1967 38 p refs Transl. into ENGLISH from Byul. Inst. Teor. Astron. (USSR), v. 8, no. 10, 1962 p 705-732
(NIC-TRANS-2492; AD-664022)

So far as celestial mechanics are concerned, the launching of artificial lunar satellites (ISL) is of great interest in the light of the possibilities of more precisely defining astronomical constants connected with the moon (mass, figure parameters, parallax, etc.), possibilities which are opening up. Here, and as distinguished from satellite tasks of classical celestial mechanics, the first order question is that concerned with the selection of those ISL orbits which would make it possible to take advantage of these possibilities in the best manner available. In solving this particular problem to be considered, on the one hand, are the specifics of the optical and radiometric observations of the ISL, and, on the other, the actions of the various perturbing factors in accordance with the orbital character. This paper is devoted to an analysis of this second part of the problem. The paper is divided up into five parts. The first three contain the first order inequalities brought about by the nonsphericity of the moons figure and by the attraction of the earth and sun. The fourth paragraph uses secular and long-period inequalities of the first order to draw certain conclusions relative to the selection of the ISL orbit in order to define more precisely the above-indicated astronomical constants. More extensive second order inequalities are introduced in the fifth paragraph. TAB

N68-18461*# California Univ., Berkeley. Space Sciences Lab.
ON THE ORIGIN OF THE SOLAR SYSTEM
Hannes Alfven (Royal Inst. of Tech.) Nov. 1967 70 p refs Presented at the Space Sci. Lab. Colloq., Berkeley, Calif., Nov. 1967 *Its* Ser. No. 8, Issue No. 105
(Grants NsG-243; NGR-05-003-230; Contract Nonr-3656(26))
(NASA-CR-93420; AD-664238) CFSTI: HC $3.00/MF $0.65 CSCL 03B

A theory of the origin of the solar system is discussed, including introduction and general principles, accretion of planets, partial corotation of a magnetized plasma, and the structure of the saturnian rings. Author (TAB)

N68-18516 Arizona Univ., Tucson.
INTERSTELLAR EXTINCTION IN THE ORION ASSOCIATION
Thomas Alan Lee (Ph.D. Thesis) 1967 199 p
Available from Univ. Microfilms: HC $9.00/MF $3.00 Order No. 67-6936

Photoelectric photometry, covering a spectral region from $\lambda = .36\ \mu$ to $3.4\ \mu$, is obtained for a large sample of early-type stars in the I Orion association with the photometric telescopes of the Lunar and Planetary Laboratory of the University of Arizona. The observations are interpreted in terms of the interstellar extinction phenomenon. The color excesses of the stars are calculated from the observed (reddened) and intrinsic (unreddened) color indices. Normalized curves revealing the wavelength dependence of the extinction are then computed. Because of the low reddening in many parts of the association, the errors of the extinction curves are often large. For this reason, regional mean extinction laws are determined from the data of individual stars in localized areas. A method that eliminates the use of filter effective wavelengths is then employed to obtain the corresponding monochromatic extinction laws. Dissert. Abstr.

N68-18521 Yale Univ., New Haven, Conn.
ON THE QUALITY OF SOLAR AND LUNAR OBSERVATIONS AND PARAMETERS IN PTOLEMY'S ALMAGEST
John Phillips Britton (Ph.D. Thesis) 1967 312 p
Available from Univ. Microfilms: HC $14.20/MF $4.00 Order No. 67-6997

This study comprises a reappraisal of several aspects of the practical astronomy of Ptolemy's Almagest. Dissert. Abstr.

N68-18527 Cornell Univ., Ithaca, N. Y.
THE INFLUENCE OF A MAGNETIC FIELD ON STELLAR ACCRETION
Joseph Arthur Burns (Ph.D. Thesis) 1966 101 p
Available from Univ. Microfilms: HC $5.20/MF $3.00 Order No. 67-1499

The stellar accretion theory of Hoyle, Lyttleton and Bondi is extended to include the possibility of the star having a magnetic field. The external field of the star is represented by a gravitational and magnetic monopole located at the center of the star and the star is considered to be moving into a uniform semi-infinite cloud of hydrogen atoms, which are un-ionized at large distances from the star. The star's radiation spectrum is represented by a Planckian distribution, given by the surface temperature of the star. The trajectory of an individual charged particle is calculated for the given magnetic-gravitational field. The particles are found to move on the surfaces of very thin cones and, if they have not yet recombined, are reflected away from the star along the same cone by a magnetic mirror effect. The exact position on the cone's surface is found from conservation of energy, as is the point of closest approach. Dissert. Abstr.

N68-18648# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INVESTIGATION OF RECOMBINATION SPECTRUM N 3 OF STARS AND NEBULAE [ISSLEDOVANIYE REKOMBINATSIONNOGO SPEKTRA I 3 ZVED I TUMANNOSTEY]
A. A. Nikitin *In its* Herald of Leningrad Univ., Math., Mech. and Astronomy Ser., No. 1, 1963 27 Apr. 1967 p 155-176 refs (See N68-18631 09-19)

The equation of statistical equilibrium for a finite number of terms is analyzed and solved in supposition that spectrum N III is recombinational. The theoretical decrement is compared with the one observed. Agreement of the theory and the observation is considered satisfactory. Author

N68-18652# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
DESCRIPTION OF METHOD OF FINDING DISTRIBUTION OF ECCENTRICITIES OF ORBITS OF VISUAL BINARIES [OPISANIYE METODA NAKHOZHDENIYA RASPREDELENIYA EKSTSENTRISITETOV ORBIT VIZUAL'NO-DVOYNYKH ZVEZD]
B. I. Fesenko *In its* Herald of Leningrad Univ., Math., Mech. and Astronomy Ser., No. 1, 1963 27 Apr. 1967 p 193-198 refs (See N68-18631 09-19)

A statistical method for finding eccentricity distribution of orbits of visual double stars is given. The method may be applied to double stars with only two observations available. Author

N68-18653*# IIT Research Inst., Chicago, Ill.
[SPECTROSCOPIC OBSERVATIONS OF MARS] Final Report, 1 Nov. 1966–31 Jan. 1968
Tobias C. Owen 27 Feb. 1968 21 p refs
(Contract NASr-65(19))
(NASA-CR-93481) CFSTI: HC $3.00/MF $0.65 CSCL 03A

Five observations of the Martian spectrum were carried out to redetermine the carbon dioxide and water vapor content of the Mars atmosphere. Improvements in the method of recording the carbon dioxide absorption bands are discussed, and as a result of these improvements, a number of high quality spectra of the weak CO_2 bands were obtained for the purpose of refining current estimates of the CO_2 abundance. Due to the successful recording of the triad of bands near the 1.05 μ region, it was possible to construct a chart of the relative bond strengths and to suggest the construction of a growth curve for CO_2 absorption in the Martian atmosphere. Based on previous observations of pressure broadened bands and the revised figure for the CO_2 abundance, the surface pressure was redetermined. The derived pressure is based on an analytical model for the band which involves known parameters such as the band strength, line widths, line spacing, etc., and leads to a value for the product of the abundance and the pressure. A comparison of the composition of the atmosphere of Mars with the total amount of evolved volatiles on earth is also presented. B.S.D.

N68-18696# Booz-Allen Applied Research, Inc., Bethesda, Md.
TARGET-MISSILE INTERCEPT TRAJECTORY PROGRAM DESCRIPTION
Alfred Terris and Ralph P. Marcotte 5 Jan. 1968 31 p
(Contract N0019-68-C-0086)
(TR-10-60-001; AD-664264)

The report describes a Fortran program which has been developed to calculate two dimensional target-missile trajectories. The report explains the program operation and usage, identifies the controls, specifies the problem input data requirements and presents a sample run. Author (TAB)

N68-18710*# Volt Technical Corp., Washington, D. C.
ON THE MOTION OF REMOTE ARTIFICIAL EARTH'S SATELLITES IN THE GRAVITATIONAL FIELDS OF THE EARTH AND OF THE MOON [O DVIZHENII DALEKIKH ISZ V BRAVITATSIONNOM POLE ZEMLI I LUNY]
V. P. Dolgachev 10 Mar. 1968 9 p refs Transl. into ENGLISH from Vestn. Mosk. Univ. Astron. (Moscow), no. 1, 1968 p 94–100
(Contract NAS5-12487)
(NASA-CR-93436; ST-CM-10687) CFSTI: HC $3.00/MF $0.65 CSCL 03C

Expressions are presented of first order perturbations of artificial earth satellite orbit elements due to Earth's oblateness, and of the second harmonic of Moon's attraction, the Moon being considered as a material point moving along a circular orbit. Formulas derived are also valid for perturbations due to the Sun. Author

N68-18768*# Army Map Service, Washington, D. C.
PRE-ORBITER INVESTIGATION Final Report
Ralph W. Harpe, Gregory J. Schiebel, and Myrna J. Short Jul. 1967 529 p refs
(NASA Order T-55870)
(NASA-CR-93433; TR-61; AD-820785L) CFSTI: HC $3.00/MF $0.65 CSCL 22A

With the National Aeronautics and Space Administration's NASA Lunar Orbiter Program forthcoming, it was necessary to determine the mapping potential of the system. This system of transmission and assembly of segments of photographs into a complete photographic frame was new. It was necessary, therefore, to determine the specific geometrical characteristics of the system as completely as possible. As the key phase of the investigation, the Army Map Service AMS, under contract to the NASA Manned Spacecraft Center MSC, Houston, Texas, produced a film strip to test the readout and assembly systems. This study was coordinated with NASA by the Defense Intelligence Agency. The analysis of the Orbiter System was of a highly cooperative nature, reflecting the interest of many organizations in achieving the maximum results from this program to further extraterrestrial exploration. During the period of this study, AMS supplied various films and other information to U.S. Geological Survey USGS, Aeronautical Chart and Information Center ACIC, and MSC. This report covers (1) mensuration of control, (2) reduction of measurements to selenodetic control, (3) production of the Special Readout Test Film, (4) analysis of the Time Data Block, (5) dusting of models for the Lunar Landmark and Simulator Materials Study, (6) analysis of the Special Readout Test Film and Goldstone Film in the Camera System Study which predicts the contour interval that can be obtained from photogrammetric models of Orbiter photography. Author

N68-18781*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
HODOGRAPHIC TREATMENT OF THE RESTRICTED THREE BODY PROBLEM, PHASE 2 Final Report
Samuel P. Altman 20 Jun. 1967 236 p refs
(Contract NAS8-20360)
(NASA-CR-61615; DIN-67SD4304) CFSTI: HC $3.00/MF $0.65 CSCL 22C

Although the two-fixed-center problem has been solved in close form by suitable selection of the problem coordinates, the restricted three-body problem has not yielded to comparable solution. The successful application of the hodograph theory of orbital mechanics to space trajectories generated in the presence of one force center suggests its extension to problems with two force centers. In view of the simpler dynamics (compared with the restricted three-body problem) and the availability of the classical solution form with two-fixed-centers, this effort is directed to hodographic formulation and solution of this problem statement. The gravitational potentials are assumed to be spherical harmonic functions. The analysis is limited to ballistic trajectories in two-dimensional space. In essence, the hodographic analysis is a specific application of the vector space (or state space) theory of processes. The ballistic trajectory (or orbit) is defined by a unique vector locus in each vector space, with geometric transformations relating the respective trajectory loci (or maps). The orbit may be simply represented in parametric form; for example, with one force center, a conic section in position vector space, a circle in velocity vector space, or a functional variant of Pascal's limacon in acceleration vector space. Author

N68-18816# Nuclear Energy Information Center, Warsaw (Poland).
RELATIVISTIC SPHERES AS MODELS OF NEUTRON STARS
B. Kuchowicz 1967 29 p refs
(NEIC-RR-28) CFSTI: $3.00

In relativistic astrophysics one deals with the set of equations for the gravitational field, pressure and density. Usually these equations are solved with help of computers. If it happens to obtain solutions expressed in terms of known functions, such exact solutions are of some use as models of superdense configurations. In two tables there are presented some solutions of such type, derived recently by the author. Author

N68-18836*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

A COLLECTION OF PAPERS RELATED TO PLANETARY METEOROLOGY

Don K. Weidner, ed. 11 Jan. 1968 180 p refs
(NASA-TM-X-53693) CFSTI: HC$3.00/MF$0.65 CSCL 03B

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N68-18837*# General Electric Co., Philadelphia, Pa. Missile and Space Div.

CHEMICAL KINETICS AND COMPOSITION OF THE MARS ATMOSPHERE

M. Bortnor and F. Alyea *In* NASA Marshall Space Flight Center A Collection of Papers Related to Planetary Meteorol. 11 Jan. 1968 p 1-28 refs (See N68-18836 09-30)
(Contract NAS8-22603)

The composition of the Martian atmosphere as a function of altitude is dependent upon the chemical kinetics. A complex chemical system has been developed, and the chemical kinetics involved have been calculated. These calculations resulted in a predicted steady-state atmosphere which gives the concentrations of eighteen species as a function of altitude. (The calculations involved fifty chemical reactions, ten of which were photochemical.) A total density distribution and three elemental compositions were assumed. Mean and extreme solar flux values were used to evaluate the effect of solar activity on the atmosphere. Based on the results obtained for the neutral species, it is found that CO_2 is more than 50 percent dissociated at all altitudes above 60 km. Above this CO and O are major constituents. Ozone is present in mole fractions comparable to those in the Earth's atmosphere. Nitrogen oxides probably do not build up in large concentrations. Charged species are more difficult to predict. Above 80 km electrons are the only important negatively charged species. Below this, negative ions become important but none build up to large concentrations.
Author

N68-18838*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

A TEMPERATURE PROFILE OF THE UPPER MARTIAN ATMOSPHERE FROM A KINETIC VIEWPOINT

James W. Johnson *In its* A Collection of Papers Related to Planetary Meteorol. 11 Jan. 1968 p 29-34 refs (See N68-18836 09-30)

To provide a model for the overall structure of the Martian atmosphere, the methods of kinetic theory are applied to the case of an ideal gas in a gravitational force field. For the lower atmosphere, the distribution function of molecular velocities can be easily obtained because the motion of the molecules comprising the system can be considered to be perfectly random. However, in the upper atmosphere, the molecular velocities are no longer isotropic, and the distribution is not easily obtained except in a certain limiting case in which collisions are so infrequent that they can be neglected altogether. If this assumption is made, the temperature profile may then be derived from a calculated atmospheric constituent distribution function. Once an adequate treatment from the kinetic viewpoint is obtained, chemical and radiative processes might possibly be regarded as perturbations.
Author

N68-18839*# Northrop Corp., Huntsville, Ala.

A METHOD FOR THE PREDICTION OF THE MARTIAN TEMPERATURE AND SOME APPLICATIONS OF METEOROLOGICAL ANALYSIS

Y. S. Lou *In* NASA Marshall Space Flight Center A Collection of Papers Related to Planetary Meteorol. 11 Jan. 1968 p 35-47 refs (See N68-18836 09-30)
(Contract NAS8-20082)

A modified radiative-convective model is established for the prediction of the surface and atmospheric temperatures at a given point on Mars in terms of earth dates. Other atmospheric parameters can be calculated from this model with the aid of the proper concept or theory. Calculations may be made at points laid out in a grid over a specific region of interest on the Martian surface, and synoptic maps of isotherms and contours can be constructed. These maps may be used to estimate the motions of the Martian atmosphere, both horizontally and vertically. It is likely that the results obtained from this modified model would show an approximate structure of the atmosphere, but further work is required to justify the validity of the model, since circulation has not been taken into account and the Martian atmosphere has been assumed to be steady state.
Author

N68-18840*# Northrop Corp., Huntsville, Ala.

PREDICTION OF MARTIAN SURFACE TEMPERATURE

F. B. Tatom, P. B. Deshpande, and F. T. Hung *In* NASA Marshall Space Flight Center A Collection of Papers Related to Planetary Meteorol. 11 Jan. 1968 p 49-68 refs (See N68-18836 09-30)
(Contract NAS8-20082)

An analytical model for predicting the surface temperature of Mars has been developed. Based on the analytical model, a digital computer program was written which locates the subsolar point on Mars, calculates the shape factor of a specific point on the Martian surface with respect to the Sun, and then solves the governing radiation and conduction heat transfer equations to establish the surface temperature, as well as the radial temperature profile beneath the surface. In developing the model, Mars was considered to be a smooth sphere with a uniform outer coating and a homogeneous interior. The atmosphere was not included in the model. The model is self-sufficient in that it can be used to predict the temperature at a specific planetegraphic latitude and longitude in terms of Earth time without use of astronomical tables.
Author

N68-18841*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

THE MSFC PLANETARY ATMOSPHERE COMPUTER PROGRAM

John Chambers (Computer Sci. Corp., Huntsville, Ala.) and Ed Seely. *In its* A Collection of Papers Related to Planetary Meteorol. 11 Jan. 1968 p 69–79 ref (See N68-18836 09-30)

The Planetary Atmosphere Computer Program contains the exact equations and most refined techniques necessary to the development of planetary atmospheric models. All of the atmospheric parameters that are essential to spacecraft design studies and aerospace operations are output in tabular form from the surface to an altitude where the planetary atmosphere may be taken to be the same as interplanetary space. Author

N68-18842*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

MARTIAN ATMOSPHERIC MODELS

Don K. Weidner. *In its* A Collection of Papers Related to Planetary Meteorol. 11 Jan. 1968 p 81–86 refs (See N68-18836 09-30)

This paper presents a mean model of the Martian Atmosphere and an envelope of extreme atmospheric density that have been developed for use in the design of spacecraft and planning of future Mars missions. The models are based upon the results of various theoretical studies and available literature. Author

N68-18843*# General Electric Co., Philadelphia, Pa. Missile and Space Div.

OUTER ATMOSPHERE STRUCTURE OF MARS

Don Vachon and K. Lichtenfeld. *In* NASA. Marshall Space Flight Center. A Collection of Papers Related to Planetary Meteorol. 11 Jan. 1968 p 87–108 refs (See N68-18836 09-30)
(Contract NAS8-22603)

A brief discussion of the probable time space variations of the outer atmosphere of Mars is presented, several atmospheric models are developed, and an empirical method is formulated for reducing density uncertainties associated with a given model by allowing for solar cyclic variations. Author

N68-18844*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

MODEL ATMOSPHERES OF MERCURY

Otha H. Vaughan, Jr. *In its* A Collection of Papers Related to Planetary Meteorol. 11 Jan. 1968 p 109–129 refs (See N68-18836 09-30)

Atmospheric models for both the sunlit and dark sides of the planet Mercury based on latest environmental data for this planet have been developed for engineering use and for preliminary design criteria guidelines. The models are considered by the author to be as realistic as available data will permit; however, as more data are obtained, they will probably need to be refined. Author

N68-18845*# Northrop Corp., Huntsville, Ala.

LIMITATIONS IN KNOWLEDGE OF THE THERMODYNAMIC PROPERTIES OF THE MARTIAN ATMOSPHERE

Wallace W. Youngblood. *In* NASA. Marshall Space Flight Center. A Collection of Papers Related to Planetary Meteorol. 11 Jan. 1968 p 131–148 refs (See N68-18836 09-30)
(Contract NAS8-20082)

Current knowledge of the thermodynamic properties of the Martian Atmosphere is reviewed, with consideration given to the vertical profiles of composition, temperature, number density, and pressure. There are major uncertainties in these profiles; in particular, a significant area of disagreement resides in identifying the main ionospheric layer measured by the Mariner IV occultation experiment as being analogous to a terrestrial F_2, F_1, or E layer. The latest values of the optical properties of the atmosphere and surface, the thermal properties of the surface, and the convective heat transfer coefficient of the atmosphere near the surface are briefly reviewed and compared. A brief discussion of potential experiments is given and includes polarization studies of CO_2 and H_2O frosts, determination of the upper atmospheric reaction rate coefficients for temperatures approaching 80°K, and determination of the convective heat transfer coefficient near the Martian surface. Author

N68-18846*# Northrop Corp., Huntsville, Ala.

SIMULATION STUDY OF MARTIAN ATMOSPHERIC COMPOSITION

T. S. Chang. *In* NASA. Marshall Space Flight Center. A Collection of Papers Related to Planetary Meteorol. 11 Jan. 1968 p 149–154 refs (See N68-18836 09-30)
(Contract NAS8-20082)

The feasibility of obtaining information related to the Martian atmospheric composition by simulating the atmosphere of Mars in an absorption tube is studied. The physical requirements for such an experiment and an existing multiple-reflection absorption tube system are briefly discussed. Author

N68-18847*# Northrop Corp., Huntsville, Ala.

SIMULATION OF THE TRANSPORTATION AND DEPOSITION OF DUST AND SAND BY MARTIAN ATMOSPHERIC PROCESSES

W. C. Lucas and W. W. Youngblood. *In* NASA. Marshall Space Flight Center. A Collection of Papers Related to Planetary Meteorol. 11 Jan. 1968 p 155–172 refs (See N68-18836 09-30)
(Contract NAS8-20082)

The feasibility of simulating the transportation and deposition of dust and sand under Martian environmental conditions is examined with a view to developing design criteria for Martian missions. The dynamic processes active in the acquisition, transportation, and deposition of unconsolidated material are analyzed and shown capable of producing dust storms and meaningful landforms on the Martian surface. Author

N68-18851*# North American Rockwell Corp., Downey, Calif. Space Div.

TECHNOLOGICAL REQUIREMENTS COMMON TO MANNED PLANETARY MISSIONS

R. D. Meston. Jan. 1968 122 p
(Contract NAS2-3918)
(NASA-CR-73188; SD-67-621-1) CFSTI: HC $3.00/MF $0.65
CSCL 22A

The performance and systems requirements of potential manned planetary missions for the 1980 to 2000 time period are examined, and areas of common requirements are established. The mission objectives considered were Mercury, Venus, Mars, and Jupiter; the asteroids, Vesta and Ceres; and Ganymede, the third Galilean satellite of Jupiter. Mission characteristics representative of opportunities having minimum, average, and maximum performance requirements during a synodic cycle of opportunities were established for each objective. Characteristics of the modules and subsystem technologies required for all missions were examined. Subsystem and module weight scaling equations were developed and, together with the performance requirements, were incorporated into the overall weight synthesis analyses. Total system requirements were defined, common manned modules were selected, and the effects of using these modules were investigated by determining the attendent increase in the propulsion module mass requirements. It was concluded that the concept of commonality can be applied at several module, system, and subsystem levels to a broad spectrum of manned interplanetary missions. M.G.J.

N68-18859 Royal Greenwich Observatory, Herstmonceux (England).
ORBITAL ELEMENTS OF NINE SPECTROSCOPIC BINARIES
Edwin S. Barker (Texas Univ., Austin, Tex.), David S. Evans, and J. D. Laing. London, HMSO, 1967. 16 p. *Its* Roy. Obs. Bull. No. 130.
HMSO: 2s 6d

Orbital elements and other data are presented for the single-lined spectroscopic binaries HD 2070, 15064, 123515, 155099, 159656, 183007, 194184 and 200334, and for the double-lined binary HD 188164. Author

N68-18869*# GCA Technology Div., GCA Corp., Bedford, Mass.
EARTH-BASED LUNAR ATMOSPHERE INVESTIGATION Final Report
F. F. Marmo, A. Engelman, H. A. Miranda, Jr., and E. Manring. Aug. 1967. 119 p. refs
(Contract NAS9-5589)
(NASA-CR-65993; GCA-TR-67-15-N) CFSTI: HC $3.00/MF $0.65 CSCL 03B

This report covers experimental instrumentation and results obtained at the Sacramento Peak Observatory in an effort of spectrometric detection and identification of atomic and/or ionic lunar atmospheric constituents in the visible spectral region. Involved was the observation of signature resonance radiations emitted from solar-illuminated constituents in the lunar atmosphere. A Fastie–Ebert type spectrometer was coupled to the Sacramento Peak coronagraph to observe the lunar atmosphere above the occulted Coude lunar image. New upper limit surface number density values were established for the constituents Na, Ca, and Ca^+. The design, fabrication, and calibration of the electronic and optical subsystems are described in detail, including the development of a suitable guidance scheme. Data analysis and interpretation are discussed. Reliable upper limit surface number density values of less than $100/cm^3$ were established for the three species cases investigated. K.W.

N68-18887 Texas Univ., Austin.
EVOLUTION OF GALAXIES AND ITS SIGNIFICANCE FOR COSMOLOGY
Beatrice Muriel Hill Tinsley (Ph.D. Thesis). 1967. 123 p.
Available from Univ. Microfilms: HC $6.00/MF $3.00. Order No. 67-8184

Theoretical magnitude-redshift relations (m–z) are constructed, for a variety of cosmological models, using the computed past history of giant elliptical systems. Three values of Hubble's constant are considered, since effects of evolution are greater if this is small. The color-redshift relation is also discussed, but effects of evolution are small in the range observed. Inclusion of galactic evolution greatly reduces the differences in m–z relations between models. This is because those models with the greatest luminosity distance at a given redshift also have the greatest light travel-time, so the galaxies would be seen earlier when they were brighter. Many cosmological models are found to be consistent with the observed m_V-z relation, including models also consistent with empirical limits on the mean density of matter, with the minimum age of the universe inferred from evolution of star clusters, and with a steep number-flux density relation for radio sources. Dissert. Abstr.

N68-18890 Texas Univ., Austin.
PERTURBATIONS OF A COSMOLOGICAL MODEL AND ANGULAR VARIATIONS OF THE MICROWAVE BACKGROUND
Arthur Michael Wolfe (Ph.D. Thesis). 1967. 93 p.
Available from Univ. Microfilms: HC $4.80/MF $3.00. Order No. 67-8174

We consider in this dissertation general relativistic, spatially homogeneous and isotropic k=o models with either pressure zero or pressure 1/3 the energy density. The equations for general linearized perturbations away from these models are explicitly integrated to obtain density fluctuations, rotational perturbations, and gravitational waves. The equations for light rays in the perturbed models are integrated. The models are used to estimate a lower limit on the anisotropy of the microwave radiation, assuming fluctuations now of order 10% with characteristic lengths now of order 1,000 megaparsecs would cause anisotropies of order 1% in the observed microwave temperature due to the gravitational red shift and other general relativistic effects. An interpretation of the mass of the density perturbations of the relatively increasing type of the p=o models is given. The p=o models are compared in detail with corresponding Newtonian models and the similarities are surprising. Dissert. Abstr.

N68-18943*# North American Rockwell Corp., Downey, Calif. Space Div.
TECHNOLOGICAL REQUIREMENTS COMMON TO MANNED PLANETARY MISSIONS Final Report
R. D. Meston. Jan. 1968. 26 p.
(Contract NAS2-3918)
(NASA-CR-73187; SD-67-1086) CFSTI: HC $3.00/MF $0.65 CSCL 22A

Requirements of a family of manned planetary missions were examined and potential areas of common requirements were established in order to determine the course of future technological development. Performance, aerobraking technology, planetary excursion module, and guidance and navigation requirements were considered in terms of the overall mission. Meteoroid, thermal, and radiation environments were investigated; and system and subsystem characteristics were studied. Manned modules, propulsion modules, and common system characteristics are reported; as are those for the life support, communications, propulsion, and electrical power subsystems. M.W.R.

N68-18958*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.
A NOTE ON THE RATE OF IMAGE ROTATION APPARENT TO AIRBORNE OBSERVERS
S. M. Smith. 1965. 14 p. refs. Submitted for publication
(NASA-TM-X-57246) CFSTI: HC $3.00/MF $0.65 CSCL 03A

A solution of the celestial triangle for the rate of apparent image rotation is presented. The known parameters of latitude, declination, local hour-angle, latitude rate, and the total rate of change from all causes of local hour angle are the terms used. The celestial triangle is depicted, in which the two apexes are the observer's zenith (Z) and the object of observation (S); the parallactic angle (Q) is considered of interest as it is the angle on the celestial sphere at S between the planes containing the observer's local vertical and the north direction. The sine and cosine formulas are used to derive the equations, and standard trigonometric substitutions are applied to obtain the final expression for the rate of apparent image rotation. M.G.J.

N68-18969# Grumman Aircraft Engineering Corp., Bethpage, N. Y. Research Dept.
AN EXPLICIT CLOSED LOOP CONTROLLER FOR GRAVITY TURN LANDING MANEUVERS
J. C. Dunn and F. Sobieralski. Mar. 1968. 58 p. refs
(RE-321)

Maintaining the thrust–drag force vector antiparallel to the velocity vector is an effective way to produce soft landings. Maneuvers of this kind are called gravity turns because the force vector component acting normal to the flight path and tending to produce a curvature in the path is due to gravity alone. A fundamental problem associated with the gravity turn is the

determination of an appropriate relationship between the instantaneous thrust–drag force magnitude and the instantaneous flight path variables, i.e., the determination of an appropriate closed loop or feedback control law for the controllable forces. It is desirable that this law take the form of a simple expression involving familiar algebraic and transcendental functions of the flight path variables. This paper develops an explicit thrust–drag feedback controller for the gravity turn and proves its effectiveness over a wide range of initial conditions. It is expected that this controller will have application to lunar and planetary missions of current interest. Author

N68-18983*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
ASTRODYNAMICS, GUIDANCE AND CONTROL REVIEW NUMBER 1
21 Feb. 1968 45 p
(NASA-TM-X-53709) CFSTI: HC $3.00/MF $0.65 CSCL 22C

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N68-18989*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
QUASI-OPTIMAL TRAJECTORY ANALYSIS WITH MULTI-MISSION CAPABILITY AND GUIDANCE APPLICATION
Roger R. Burrows *In its* Astrodyn., Guidance and Control Rev. No. 1 21 Feb. 1968 p 27–29 (See N68-18983 09-30)

A trajectory analysis computer program called Quasi-Optimal Trajectory Analysis (QUOTA) is described. The program which uses a control law allowing closed form solutions of the differential equations of motion, numerically solves mission terminal conditions as well as equations representing necessary optimality conditions. This accounts for QUOTA's mission flexibility and the inclusion of necessary conditions for an optimum trajectory. It is shown how QUOTA achieves its multimission capability when used as an onboard guidance system. The control law used by the current vehicle guidance system, the IGM, is compared with that used by QUOTA, and the theoretical conditions for which they are optimal control laws are discussed. A numerical algorithm that allows the possibility of real time onboard guidance is mentioned, and some future applications of QUOTA are assessed. B.S.D.

N68-19008*# National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York.
RADIATIVE TERMS IN THE THERMAL CONDUCTION EQUATION
Richard W. Stewart [1967] 26 p refs
(NASA-TM-X-60925) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Those terms in the thermal conduction equation which arise due to infrared emissions and absorptions by atomic oxygen and carbon monoxide are investigated. The purpose of this investigation is to develop general expressions for the net emission by O and CO which take account of absorption from the planetary black-body spectrum and from other regions of the thermosphere and are thus valid at all optical depths in the thermosphere. The radiative terms are developed under the assumptions of local thermodynamic equilibrium and an Eddington approximation for the radiation field. The results are compared to the Bates' approximation to the radiative loss terms for a Martian model atmosphere which is optically thick in both O and CO. It is found that the net emission differs from the Bates' expressions by more than an order of magnitude near unit optical depth and that absorption causes the emission to be somewhat less than the Bates' approximation in optically thin regions of the high thermosphere. Author

N68-19020*# Northrop Space Labs., Huntsville, Ala.
LUNAR DUST DEGRADATION EFFECTS AND REMOVAL/PREVENTION CONCEPTS. VOLUME 1: SUMMARY Final Report
F. B. Tatom, Vanja Srepel, R. D. Johnson, N. A. Contaxes, J. G. Adams et al 7 Jun. 1967 19 p
(Contract NAS8-20116)
(NASA-CR-93594; TR-792-7-207A, V. 1; TR-321) CFSTI: HC $3.00/MF $0.65 CSCL 22A

The report presents the results of a research effort to determine the degradation of radiator surfaces due to contamination by simulated lunar dust and to develop methods of removing or preventing the accumulation of dust on radiator surfaces. Spectral and total solar absorptance values of S-13 and aluminized Teflon thermal control coatings are presented for various degrees of basalt dust contamination and at two different angles of incidence. Both spectral and total infrared emittance values for S-13 and aluminized Teflon are provided for various loads of dust coverage. The designs of several devices for removing or preventing dust accumulation are presented along with test results based on performance testing of these devices. The devices tested include a jet cleaning device, a vibrating surface device, and a mechanical brush device. The report indicates that dust contamination, even at a relatively low level, can produce significant increases in the solar absorptance of a thermal control coating. There is indication, based on the experimental results reported that the use of an incompressible fluid jet is the most promising method of removing dust of those devices tested. Author

N68-19064*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
LUNAR BEACONS: A PRELIMINARY LOOK AT THEIR POSITION ESTIMATION AND THEIR USE IN LUNAR ORBIT ESTIMATION
Thomas M. Carson Washington Mar. 1968 20 p refs
(NASA-TM-X-1529) CSCL 22A

In the estimation of a lunar orbit, various data sources could be used. This report considers the use of on-board range and range-rate measurements of lunar beacons as an addition to the normal use of range-rate measurements from earth-based stations. The analysis considers both the improvement of the orbit estimation and the estimation of the location of the lunar beacons. The orbit estimation and the estimation of the location of the Schmidt–Kalman filtering process was used for the estimation. Random errors in the measurements and bias errors in the station and beacon locations were considered. Results show that the addition of on-board measurements of lunar beacons to earth-based range-rate measurements contributes significantly in the estimation of the orbit and in the knowledge of the beacon locations. Author

N68-19093*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
VOYAGER SPACECRAFT PHASE B, TASK D. VOLUME 4: ENGINEERING TASKS. BOOK 4: MARS ATMOSPHERE DEFINITION Final Report
16 Oct. 1967 114 p refs
(Contract NAS8-22603)
(NASA-CR-93537; DIN-67SD4379, V. 4, Bk. 4) CFSTI: HC $3.00/MF $0.65 CSCL 22A

To provide definition of the Martian atmospheric characteristics required by spacecraft designers, existing Martian atmosphere guides were used, including the findings based on the Mariner 4 data, and the spectroscopic data obtained during the recent opposition. Empirical methods were developed to estimate the parameter values required, and a theoretical analysis of the chemical kinetics and the composition of the atmosphere was made in order to better understand the probable time–space characteristics of the upper atmosphere. Based on these investigations, extensive data are presented on the physical properties, the atmospheric parameter near the surface, entry atmosphere models, outer atmosphere structure, clouds and haze, and predictions of the atmospheric composition as a function of altitude. M.G.J.

N68-19119 Texas Univ., Austin.
OPTIMIZATION OF NONLINEAR SYSTEMS WITH INEQUALITY CONSTRAINTS
Gary Joseph Lastman (Ph.D. Thesis) 1967 132 p
Available from Univ. Microfilms. HC $6.40/MF $3.00 Order No. 67-8123

A nonlinear optimization problem with inequality constraints is formulated. Two general types of inequality constraints are examined: one which explicitly contains the control variables and one which does not (state-variable constraint). It is found that a state-variable constraint can be replaced by an inequality constraint containing the control, in addition to some intermediate boundary conditions. A reformulated nonlinear optimization problem with inequality constraints (containing the control) and intermediate boundary conditions is then analyzed to obtain conditions which the optimal trajectory must satisfy. Computer algorithms based on new perturbation method for inequality-constrained problems are derived. As an example, the numerical solution of a nonlinear optimization problem with inequality constraints is presented. The problem is a mathematical model of an Earth–Mars transfer trajectory. Dissert. Abstr.

N68-19139*# National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York.
THE EXPLORATION OF PHOBOS AND THE CONSTANT OF GRAVITATION
A. Finzi Feb. 1968 10 p refs
(NASA-TM-X-60921) CFSTI: HC $3.00/MF $0.65 CSCL 22A

It would be easier to land a spacecraft gently on Phobos, the tiny Martian moon, than on Mars. The study of Phobos' material could provide information about the origin of Mars. Detailed information about the Martian relief could be derived from the analysis of the radio signals before and after each occultation of Phobos by Mars. Finally, the Doppler Tracking Data would yield the accurate values of the coefficients of the development of Mars' potential in spherical harmonics and would provide an opportunity to test the hypothesis that Newton's constant varies with the gravitational potential. The result of this test could have fundamental impliciations in Relativistic Astrophysics and Cosmology. Author

N68-19168# Joint Publications Research Service, Washington, D. C.
ASTRONOMY
In its Soviet-Bloc Res. Geophys., Astronomy and Space, No. 176 20 Mar. 1968 p 1–8 refs (See N68-19167 09-13)

News articles and abstracts of scientific articles in astronomy deal with subjects such as stellar physics and sunspots, threshold photomultipliers, and distribution of asteroids and fragments of primary bodies. Solar wind and shock wave propagating from flares, time dependence of X-radiation of a 1960 solar flare, and characteristics of flares accompanied by Type-IV bursts are reviewed. Other abstracts deal with millimeter wave spectrum of Venusian emission, activity centers in heliogeographic longitude, the metallic component in a bright prominence, and wave motions in regions of continuous emission bands. M.W.R.

N68-19186*# North American Aviation, Inc., Downey, Calif.
GUIDANCE, FLIGHT MECHANICS AND TRAJECTORY OPTIMIZATION. VOLUME 12: RELATIVE MOTION, GUIDANCE EQUATIONS FOR TERMINAL RENDEZVOUS
D. F. Bender and A. L. Blackford Washington NASA Apr. 1968 97 p refs
(Contract NAS8-11495)
(NASA-CR-1011; SID-66-1678-4) CFSTI: HC $3.00/MF $0.65 CSCL 22C

This monograph is intended to present a discussion of the principles and techniques of accomplishing a rendezvous between two spacecraft. In the context here, rendezvous is considered as the interface between the midcourse corrections of an orbital transfer maneuver which establishes the two spacecraft on nearly identical orbits and the docking maneuver which results in the physical contact of the two spacecraft. First consideration in the discussion is given to the development of the equations of relative motion of the two vehicles. To facilitate the use in guidance scheme, these equations are developed in various coordinate systems, with several choices for the independent variables, and with several simplifying assumptions. Next, guidance schemes are developed based on these equations of motion. As each guidance scheme is presented, its existance is in some way justified and the relative advantages and disadvantages as compared to the other schemes discussed. With this discussion enough information is available so that the elements of a rendezvous guidance scheme can be constructed for a particular set of conditions in which a rendezvous maneuver is required. Author

N68-19192*# St. Louis Univ., Mo.
SUBSOLAR-MERIDIAN MEAN ANNUAL DISTRIBUTIONS FOR MARTIAN TROPOSPHERE BELOW 50 KILOMETERS
F. C. Bates Washington NASA Mar. 1968 51 p refs
(Grant NGR-26-006-016)
(NASA-CR-1043) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Available observations of the Martian atmosphere were employed to estimate the composition of the homogeneous atmosphere and equivalent-mean-sea-level pressure. A mean-annual subsolar-meridian distribution of temperature, pressure and zonal-wind speed was then constructed for a depth of 50 km based on the foregoing estimates and: (1) a wave regime; (2) hydrostatic balance; (3) midlatitude scale height consistent with Mariner IV observation; (4) tropopause height varying from 30 km at the equator to 10 km at the pole; (5) mean jet-stream position at 45° latitude and 20 km; and (6) estimates from similarity to Earth and other rotating-fluid systems. These results were then extended to an estimate of wind and wind regimes, including secondary circulations such as extra-tropical cyclones and yellow-dust devils. Computations of heating rates in a ten-layer model were used to test soundings at several latitudes to determine required dynamic and/or advective compensation. Author

N68-19198*# National Aeronautics and Space Administration, Washington, D. C.
TEN YEARS OF SPACE RESEARCH IN THE USSR [DESYAT' LET ISSLEDOVANIYA KOSMOSA V SSSR]

M. K. Tikhonravov, B. V. Raushenbakh, G. A. Skuridin, and O. L. Vaysberg Feb. 1968 43 p refs Transl. into ENGLISH from Kosmich. Issled. (Moscow), v. 5, no. 5, 1967 p 643-679
(NASA-TT-F-11500) CFSTI: HC $3.00/MF $0.65 CSCL 22A

A chronological account is given of the development of Soviet astronautics from the launching of the first satellite in 1957 until the present. The purposes of the satellites and their crews and performance are discussed. The second part of the paper covers various natural phenomena occurring at high altitudes and in space, and describes how Soviet spacecraft have provided additional knowledge about these phenomena. Photographs of representative satellites from each series are included. Author

N68-19199*# National Aeronautics and Space Administration. Electronics Research Center, Cambridge, Mass.
TEMPERATURES IN THE UPPER ATMOSPHERE OF VENUS AS INDICATED BY THE INFRARED CO_2 BANDS
Philip L. Hanst [1963] 26 p refs Presented at the Opt. Soc. of Am., Mar. 1966
(NASA-TM-X-57346) CFSTI: HC $3.00/MF $0.65 CSCL 03A

The appearance of the infrared emission spectrum of Venus is considered with regard to its implications as to (1) the emissivity of the clouds of Venus, (2) the temperature of the atmosphere in the vicinity of the clouds, and (3) the temperature profiles in the atmosphere above the clouds. Computations are made of the emission and absorption in the 10.4 micron band of CO_2 under a variety of different assumptions of emissivity and temperature. The infrared emission spectrum requires the emissivity of the clouds to be at least as high as 0.65, and the temperature of the clouds to be less than 250°K. The atmospheric temperature most likely decreases with increasing altitude in the vicinity of the clouds. The spectrum also indicates an absence of temperature inversions and associated warm zones in the upper atmosphere, unless they are at extremely high altitudes. Author

N68-19223*# North American Rockwell Corp., Downey, Calif. Space Div.
TECHNOLOGICAL REQUIREMENTS COMMON TO MANNED PLANETARY MISSIONS. APPENDIX D: SYSTEM SYNTHESIS AND PARAMETRIC ANALYSIS Final Report
R. D. Meston Jan. 1968 226 p refs
(Contract NAS2-3918)
(NASA-CR-73192; SD-67-621.5, App. D) CFSTI: HC $3.00/MF $0.65 CSCL 22A

Parametric designs have been made of the modules that form the systems (vehicles) to accomplish the designated missions. Conceptual design drawings have been made as necessary to allow formulation of weight-scaling equations based on realistic configurations. These equations are used in the Weight Synthesis Computer Program to examine the sensitivity of these vehicles to variations in design approach and uncertainties in design requirements. Conceptual designs will be discussed first, followed by the resulting weight-scaling equations, weight synthesis methodology, and parametric analysis. Author

N68-19239*# Boeing Co., Seattle, Wash. Space Div.
INTEGRATED MANNED INTERPLANETARY SPACECRAFT CONCEPT DEFINITION. VOLUME 3: SYSTEM ANALYSIS. PART 1: MISSIONS AND OPERATIONS Final Report
Jan. 1968 270 p refs
(Contract NAS1-6774)
(NASA-CR-66560; D2-113544-3-1) CFSTI: HC $3.00/MF $0.65 CSCL 22C

In this volume, trajectories are defined for missions to Mars and Venus during the time period 1975 to 1990. Analyses of Earth departure penalties and elliptical orbits at the planets are included. Trajectory optimizations are presented for the case of aerobraking at the planets. Mission profiles are defined and crew workloads are derived. Estimates of mission success probability are given and the short capability is presented for the recommended IMISCD space vehicle. Author

N68-19242*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
WORKING WITH ORBITS
Dale E. Gerster (Prince George's County, Md.) Feb. 1968 20 p Revised
(NASA-TM-X-63126; X-207-67-434) CFSTI: HC $3.00/MF $0.65 CSCL 22A

Calculations are given to describe the general motion of a satellite. Through these calculations the size and shape of an orbit is defined, and the required velocity at perigee, apogee, and some intermediate points are calculated. It is noted that the perigee and apogee velocities form a 90° angle with a line through the center of the earth, but the angles at other points in the orbit will not be 90°. Using these angles and the calculated force for gravity at these various points, the velocity change between points is predicted, showing that only gravity is necessary to determine the elliptical path of a satellite. Based on energy considerations, the velocity needed for an object to escape from the influence of gravity and leave the earth is calculated. The various quantities involved in orbit calculations such as energy, angular momentum, and gravity are discussed, and the details of these calculations are shown. B.S.D.

N68-19286# Smithsonian Astrophysical Observatory, Cambridge, Mass.
A WINDBLOWN DUST MODEL OF MARTIAN SURFACE FEATURES AND SEASONAL CHANGES
Carl Sagan and James B. Pollack 8 Nov. 1967 54 p refs
(SAO Special Rept.-255)

A model of seasonal changes on Mars and related phenomena is developed with dust, winds, and elevation differences as the principal ingredients. A comparison of the velocities required for dust mobility on Mars with those predicted by theoretical meteorology, as well as observations of yellow clouds on Mars, indicates that grains on the Martian surface are moved by saltation, suspension, and creep. Mars exhibits very steep meridional temperature gradients in winter and very shallow such gradients in summer. This leads to significant changes in the zonal wind velocities and therefore in the mean particle size of the dark areas. For all reasonable velocity distribution functions, these particle-size changes are just the amounts implied by photometric and polarimetric observations of the wave of darkening. Springtime brightening of Martian bright areas, anomalous darkening of dark areas caused by the passage of dust clouds, and the existance and numerical value of a maximum darkening of the dark areas are all correctly predicted on this model. A number of other statistical regularities of the seasonal changes, as well as the rapid regeneration of dark areas after coverage by dust, the secular changes, and the seasonal changes of the canals all have a straightforward explanation in the context of the windblown dust model. Author

N68-19308 IIT Research Inst., Chicago, Ill.
ENVIRONMENTAL EFFECTS ON ENGINEERING PROPERTIES OF SIMULATED LUNAR SOILS
John David Nelson (Ph.D. Thesis) 1967 248 p
Available from Univ. Microfilms: HC $11.25/MF $3.20 Order No. 67-8963

A program of research was conducted to investigate the properties of soil in a simulated lunar environment. Experiments were performed on both fine and coarse grained soils in order to permit the application of the results to almost any reasonable

estimate of the lunar surface. The primary environmental factors that were considered were ultrahigh vacuum and temperature. The porosity attained by soil during deposition was observed to vary with the atmospheric pressure of the surrounding environment. At low vacuum levels (10^{-3} torr) the porosity was less than that attained in atmosphere (760 torr) because of the absence of frictional air resistance on falling particles. At high and ultrahigh vacuum levels the porosity increased indicating the development of a honeycomb or flocculent grain structure supported by interparticle forces. For quartz, the porosity attained at vacuum levels higher than 10^{-7} torr was greater than that attained in atmosphere. Dissert. Abstr.

N68-19315*# North American Aviation, Inc., Downey, Calif.
GUIDANCE, FLIGHT MECHANICS AND TRAJECTORY OPTIMIZATION. VOLUME 13: NUMERICAL OPTIMIZATION METHODS
J. E. McIntyre Washington NASA Mar. 1968 109 p refs
(Contract NAS8-11495)
(NASA-CR-1012; SID-66-1678-5) CFSTI: HC $3.00/MF $0.65 CSCL 22C

A monograph is presented on the second step in the optimization process, which generates numerical solutions. The three fundamental numerical procedures—neighboring external, steepest-descent and quasilinearization—are presented, and their application to both classical and nonclassical problems are shown. Two numerical methods for locating the minimum value of a function are reviewed; an extrapolation of these methods into a function space leads to the three fundamental techniques for locating the minimum value of a functional. The step by step calculation procedure used in each of these techniques is given for the classical Mayer problem and nonclassical versions of the Mayer problem arising in modern trajectory and control applications. The relative merits of each technique are discussed, and it is shown that the iterative numerical procedures used for solving nonlinear optimization problems consist in approximating the problem by a succession of linear problems. B.S.D.

N68-19316*# Philco-Ford Corp., Palo Alto, Calif. Space and Re-Entry Systems Div.
VENUS SWINGBY TRAJECTORIES; ESTIMATION OF INERTIAL PLATFORM ERRORS; INTERPLANETARY NAVIGATION AND GUIDANCE ANALYSIS
21 Oct. 1967 141 p refs
(Contract NAS8-20358)
(NASA-CR-61646; TR-DA1568) CFSTI: HC $3.00/MF $0.65 CSCL 22C

A handbook is presented on the Mars return trajectories that utilize Venus as an intermediate body. The return flight, which varies from 200 days to 400 days, is done with a 10 day by 10 day grid for each opposition from 1971 to 1999 inclusive. The mathematical analysis used for the trajectory calculations and the planetary ephemeris are described and tabulated trajectory data are presented. The feasibility of estimating the inertial guidance platform errors from data obtained during a powered flight ascent is evaluated by simulating an orbit determination process that combines the telemetry and tracking data. The equations for the platform model, the tracking modes, and minimum variance estimation are presented. A computer program used to generate the covariance matrix of errors, and the nominal ascent trajectory along which the covariance matrix is propagated, is discussed. The effects of individual error sources in the platform and tracking systems are examined, and the results are used to define the significant error sources which should be included in the combined platform-tracking system model. The onboard navigation performance under the influence of equation of motion errors and measurements biases is evaluated. The error sources are identified and their effects on the system performance for a variety of trajectories are shown. B.S.D.

N68-19330*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A FORTRAN PROGRAM FOR COMPUTATION OF MASS IN EARTH ORBIT REQUIRED FOR INTERPLANETARY MISSIONS
Samuel W. Pitts and Alfred C. Mascy Washington Apr. 1968 29 p ref
(NASA-TM-X-1541) CFSTI: HC $3.00/MF $0.65 CSCL 22A

A necessary parameter to be investigated in the analysis of space missions is the total assembled mass in Earth orbit, as it is a strong indicator in comparisons of the performance of various propulsion systems. The computer code described in this paper was designed to compute the mass in Earth orbit for round-trip stopover missions, flyby missions, and orbiter missions with a single-stage high-thrust system for each propulsive phase. The actual gravity losses suffered during each propulsive phase are computed by complete integration of the equations of motion, thereby permitting the propulsion system to be optimized. The program allows the input of planet ephemeris data so that it may be used for any planet. Author

N68-19344*# Smithsonian Astrophysical Observatory, Cambridge, Mass.
THE EARLY A STARS 2: MODEL ATMOSPHERE ABUNDANCE ANALYSIS OF EIGHT STARS IN THE PLEIADES
Peter S. Conti (Calif. Univ., Santa Cruz) and Stephen E. Strom Aug. 1967 20 p refs
(Grant NGR-22-024-001; Contract AF 49(638)-1323)
(NASA-CR-93687; Rept.-706-39) CFSTI: HC $3.00/MF $0.65 CSCL 03A

Stars near spectral type A0, showing anomalously low ratios of Sc II λ4246/Sr II λ4215, are found to be analogous to the classically defined Am stars. This result follows from a detailed model atmosphere study of eight sharp-line A stars in the Pleiades. For the four Am analogues among these stars, the following anomalies are found: underabundances of carbon, calcium, and scandium; overabundances of strontium, yttrium, zirconium, and barium; and high microturbulent velocities. The analysis shows clearly that these anomalies cannot be attributed solely to inappropriate choices of atmospheric parameters. The normal A stars in our sample show excellent agreement in their element abundances with field A stars such as Vega. Author

N68-19348*# Smithsonian Astrophysical Observatory, Cambridge, Mass.
ON THE VARIATION OF THE MICROTURBULENCE PARAMETER WITH CHEMICAL COMPOSITION
S. E. Strom Jan. 1968 6 p refs
(Grant NGR-22-024-001)
(NASA-CR-93686) CFSTI: HC $3.00/MF $0.65 CSCL 03B

It is shown that the correlation found by previous investigators between the value of the microturbulent velocity parameter Ξ_t and the iron to hydrogen ratio for G dwarfs results from invalid assumptions implicit in the differential curve-of-growth techniques used to derive Ξ_t. By using model atmosphere abundance analyses, the deduced values of Ξ_t will be very close to the mean value found for stars for approximately solar composition. Author

N68-19353*# Bellcomm, Inc., Washington, D. C.
EFFECT OF EARTH OCCULTATION ON ASTRONOMICAL OBSERVATIONS FROM EARTH ORBIT
D. B. Wood 15 Feb. 1968 16 p
(Contract NASw-417)
(NASA-CR-93474) CFSTI: HC $3.00/MF $0.65 CSCL 03A

The effect of the occultation of the celestial sphere by the earth upon astronomical observations from earth orbit is

investigated as a function of orbital altitude, orbital inclination, and viewing direction. As the viewing direction approaches the orbital poles the total possible viewing time increases. Near the orbital poles there are unocculted circles which move around the celestial sphere at constant declination as the node regresses. Low earth orbits of intermediate inclination yield continuous viewing times of celestial objects within these circles on the order of 11 days, even though the orbital period is only 93 minutes. For an orbital observatory at a given inclination, the observing program is best directed toward the unocculted zones. Three astronomical observatories in low earth orbit (450km), at inclinations 15°, 45° and 75°, could cover the entire celestial sphere with their unocculted circles in about two months. For polar (90°) or equatorial (0°) orbits the unocculted circle always views the same limited portion of the sky. Author

N68-19354*# Bellcomm, Inc., Washington, D. C.
EXPERIMENT PAYLOADS FOR MANNED ENCOUNTER MISSIONS TO MARS AND VENUS
W. B. Thompson, J. E. Volonte, G. A. Briggs, P. L. Chandeysson, M. Cutler et al 21 Feb. 1968 65 p refs
(Contract NASw-417)
(NASA-CR-93569; TR-68-710-2) CFSTI: HC $3.00/MF $0.65 CSCL 22C

Trajectory opportunities were identified for free return manned flyby, or encounter, missions to Mars and Venus. Selecting as a design reference mission a triple planet (Venus–Mars–Venus) flyby with a 1977 earth launch date, a possible experiment program is outlined which employs unmanned probes to explore Mars and Venus during the planetary encounter phase. To complement this a program of space science and astronomy experiments is carried out during the remaining portion of the mission. A precursory unmanned program of orbital reconnaissance missions with small atmospheric and survivable surface impacter probes is assumed for both planets. Several en route experiments were identified which take particular advantage of the trajectory of the design reference mission. These include optical observations of Zodiacal light, several known asteroids, Mercury, and the moons of Mars. Radio observations of Jupiter and the sun made in conjunction with an earth-based station would also be of interest. Author

N68-19355*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
LUNAR SOLAR PERTURBATIONS OF A 24 HOUR SATELLITE
B. K. Martynenko Redstone Arsenal, Ala. Redstone Sci. Inform. Center 28 Dec. 1967 29 p refs Transl. into ENGLISH from Inst. Teor. Astron., Biulleten v. 11, no. 1, 1967 p 33–47
Sponsored jointly by NASA and Army Missile Command
(NASA-TM-X-60931; RSIC-740) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Study of the lunar–solar gravitational perturbations of two hypothetical earth satellites having a sidereal period of $23^h56^m04^s$. The orbit of the first satellite lies in the equatorial plane while that of the second is perpendicular to the ecliptic plane. At the initial moment (12^hE.T., January 0, 1950), the nodes of the orbits of the two satellites and the moon coincide. The perigee distance of the first satellite is chosen so as to minimize the secular excitations of the orbital eccentricity at fixed values of all the remaining elements. The orbital parameters of the second satellite are chosen according to the condition of maximum secular perturbations of the orbital eccentricity. The orbital eccentricity of the first satellite is 0.1, while that of the second is 0.6. Results show that the orbit of the first satellite is stable and orbital eccentricity decreases at the rate of 0.00127 per year. Rapid increase in the eccentricity of the second satellite limits its lifetime to 5.5 years. Secular and periodic first order perturbations are calculated. Author

N68-19357*# Volt Technical Corp., Washington, D. C.
ON SECULAR ACCELERATION OF PERIODICAL MOTION OF COMETS
A. D. Dubyago 18 Mar. 1968 12 p refs Transl. into ENGLISH from Astron. Zh. (USSR), 1948 p 362–368
(Contract NAS5-12487)
(NASA-CR-93471; ST-COM-CM-10681) CFSTI: HC $3.00/MF $0.65 CSCL 03C

Comparison is made between secular variations of the mean twenty-four-hour motion and eccentricity, independent of planets' perturbation, for comet Encke according to Asten research, for comet Biela according to Hepperger's research, for comet Brooks according to author's theory, for comet Winnecke according to Haerdtl's works, and for comet Wolf according to Kamienski theory. Alongside with secular acceleration there exists a secular deceleration of motion, which incidentally does not reach the high values attained by the acceleration. Hypotheses used to explain motion anomalies of planets, are questioned. The results obtained for comet Brooks contradict the Backlund's hypothesis about comet's encounter with meteor streams. Investigation of Bessel's hypothesis showed that anomalies in the motion of comets proved to be the reaction on the masses ejected by the comet's body. If this hypothesis is correct, then we must admit the ejection by the comet, of not only gaseous, but also of hard particles, in agreement with Bredikhin's theory about the role of comets' anomalous tails. Author

N68-19361*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
THE LUNAR AND PLANETARY X-RAY DIFFRACTION PROGRAM: A SUMMARY
James A. Dunne and Neil L. Nickle 15 Mar. 1968 30 p refs
(Contract NAS7-100)
(NASA-CR-93665; JPL-TR-32-1248) CFSTI: HC $3.00/MF $0.65 CSCL 03B

A summary of the knowledge and experience gained in the course of the program concerning the application of X-ray diffraction instrumentation to lunar and planetary exploration is presented. As a result of the work reported, the salient design features of such instrumentation have been well established, and instrument development research can be said to be complete within the present state of the art. Author

N68-19376*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
ACCELERATION HODOGRAPH ANALYSIS TECHNIQUES FOR POWERED ORBITAL TRAJECTORIES, PHASE 3 Final Report
Samuel P. Altman 20 Jun. 1967 291 p refs
(Contract NAS8-20360)
(NASA-CR-61616; DIN-67SD4300) CFSTI: HC $3.00/MF $0.65 CSCL 22C

Hodographic equations of motion, with time as the independent variable, are developed for the synthesis and analysis of powered orbital trajectories in acceleration vector space. A generalized variational problem in orbital mechanics is formulated, using the equations of motion in an inverse square gravitational force about one force center. A hodographic analysis of orbital trajectories subject to essentially impulsive thrust which provides instantaneous changes in the orbital velocity vector is accomplished in velocity vector space. This is possible because an orbital hodograph in a given vector space presents directly, by means of line elements and angles, explicit and geometrically interrelated data not only on the trajectory vectors in that space, but also on the vectors in all lower orders of vector space. Transformation functions of the orbital hodographs are described, and it is shown how elapsed time between two points along an orbital trajectory can be calculated by equations representing an area swept out in velocity vector space. Vector space analysis of orbital trajectory classes for mission studies

are discussed, and the differential geometry of orbital trajectory fields are represented in acceleration vector space. E.J.S.

N68-19381*# Physics Technology Labs., Inc., La Mesa, Calif.
INVESTIGATION OF LUNAR SOIL MODIFICATION DUE TO BOMBARDMENT BY SIMULATED SOLAR PLASMA WIND Final Report, Apr. 1966–Mar. 1967
Mar. 1967 174 p refs
(Contract NAS9-5923)
(NASA-CR-93535; A-0045) CFSTI: HC $3.00/MF $0.65 CSCL 03B

This research effort was instituted to provide the equipment capability for the exposure of typical simulated lunar soil material to simulated solar wind flux. Also, the data collection, analysis and interpretation of interaction effects of selected, bombarded test samples, their ejecta and condensates were corollary objectives of this program. Olivine was selected as a typically representative "building-block" mineral constituent of common rocks and a likely candidate for lunar soil constitution. The samples used for solar wind exposure were gem quality, carefully oriented and given a fine surface polish by a unique method developed for this purpose. The bombarded olivine sample surfaces were examined by electron and metallographic microscopes for topographic sputter induced phenomena which would bear relationship to the crystal lattice damage effects produced by hydrogen and argon ion bombardment of surfaces and subsequent gas implantation. Author

N68-19391*# Philco-Ford Corp., Newport Beach, Calif. Space and Re-Entry Systems Div.
SPACE AND RE-ENTRY SYSTEMS: DEVELOPMENT OF ADVANCED SOIL SAMPLER TECHNOLOGY, VOLUME 2 Final Report, 28 Jun. 1967–31 Jan. 1968
George P. Zebal and Wilfred H. Bachle 31 Jan. 1968 206 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951935)
(NASA-CR-93679; UG-4289, V. 2) CFSTI: HC $3.00/MF $0.65 CSCL 22A

As part of an advanced soil sampler technology program, these appendices contain descriptions of the soil models used in the laboratory testing phase of the program, the field test sites, the viability and biochemical assay procedures, a soil analysis for particle size distribution and mineralogical composition, and a field test site control sample analysis. Also included are particle size distribution curves for the field test sites, a bibliography on passive sampling, and a soil transport analysis. R.N.A.

N68-19394*# Philco-Ford Corp., Newport Beach, Calif. Space and Re-Entry Systems Div.
SPACE AND RE-ENTRY SYSTEMS: DEVELOPMENT OF ADVANCED SOIL SAMPLER TECHNOLOGY, VOLUME 1 Final Report, 28 Jun. 1967–31 Jan. 1968
George P. Zebal and Wilfred H. Bachle 31 Jan. 1968 269 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951935)
(NASA-CR-93678; UG-4289, V. 1) CFSTI: HC $3.00/MF $0.65 CSCL 22A

A vertically deployed conical abrading sieve sampler and a deployable rotating wire brush sampler were tested under field conditions which simulated, to some extent, the projected characteristics of the Martian surface. The results of the test efforts are presented in terms of mechanical operation and sampler acquisition performance. All of the samplers were able to obtain a sample of dune sand of useful sizes; i.e., tens to hundreds of grams. The field testing provided soil models such as the playa dry lake duricrust, desert pavement, and the compacted cinders. The samplers were able to sample these sites with varying degrees of success. None of the samplers could obtain useful samples from the lava flows. Biological evaluation of selected samples acquired by the samplers were generally inconclusive. A separate task included a literature survey and a limited analysis to provide design information applicable to passive soil samplers. The results indicate that, providing the mechanisms are available on Mars to produce the requisite winds in the currently postulated atmospheric models, passive sampler concepts can be developed which will incur very little weight or volume penalties to the spacecraft. Author

N68-19398*# Smithsonian Astrophysical Observatory, Cambridge, Mass.
SURFACE GRAVITY DETERMINATIONS FOR MAIN-SEQUENCE B STARS
S. E. Strom and D. M. Peterson Aug. 1967 22 p refs
(Grant NGR-22-024-001)
(NASA-CR-93691) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Hydrogen-line equivalent widths computed from model atmospheres have been used to obtain values of surface gravity for B stars by comparison with observed Hγ equivalent widths. The effects of stellar rotation and differing line-broadening theories on the deduced gravities are discussed. When the effects of rotation are allowed for the Edmonds, Schlüter, and Wells semi-empirical Stark broadening theory is used, a mean surface gravity, log g = 4.25, is found for B stars. This determination lies within 0.1 in the log of the values deduced from double-lined eclipsing binary systems and computed interior models for B stars. Author

N68-19429*# North American Rockwell Corp., Downey, Calif. Space Div.
TECHNOLOGICAL REQUIREMENTS COMMON TO MANNED PLANETARY MISSIONS. APPENDIX B: ENVIRONMENTS Final Report
R. D. Meston Jan. 1968 107 p refs
(Contract NAS2-3918)
(NASA-CR-73190; SD-67-621-3, App. B) CFSTI: HC $3.00/MF $0.65 CSCL 22A

The meteoroid, thermal, and radiation protection requirements have been determined for the missions being considered. The objective of the meteoroid protection studies was to develop meteoroid shield scaling equations. The meteoroid protection requirements are expressed as a set of scaling equation coefficients which define the shield weight as a function of the mission objective, spacecraft configuration, and mission duration. The purpose of the thermal requirements study was to develop weights and weight scaling equations for all systems and structural aspects of long-term space vehicles. The heat balances and requirements on the mission module and the thermal protection required for propellant storage are considered. The radiation protection study developed shielding requirements for the interplanetary legs of the missions, and special consideration was given requirements resulting from the Jupiter trapped radiation belt. Author

N68-19437*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
COMPOSITION OF THE LUNAR HIGHLANDS: POSSIBLE IMPLICATIONS FOR EVOLUTION OF THE EARTH'S CRUST
Paul D. Lowman, Jr. Mar. 1968 31 p refs
(NASA-TM-X-63141; X-644-68-87) CFSTI: HC $3.00/MF $0.65 CSCL 03B

This paper analyzes the possible implications of the composition of the lunar highlands for the origin of terrestrial continents and ocean basins. The highlands probably correspond chemically to ultrabasic, basic, or intermediate to acidic igneous rocks. If they are dominantly ultrabasic or basic, this would imply that the terrestrial continental crust may be essentially sedimentary in origin. However, evidence from various Precambrian studies indicates that the rate of continental growth by island and accretion is so slow that five

billion years would not be enough time for the continents to attain their present size and thickness. An alternate implication is that the continents are derived from the mantle by some igneous process related to formation of the earth's core in early Precambrian time. A third possibility is that the continents are meteoritic additions to the earth, and that these supposed bodies missed the moon. A basic lunar highland composition would imply that the lower continental crust layer and the main oceanic crust layer may be the original or nearly-original basaltic crust of the earth. Author

N68-19456*# Bendix Corp., Ann Arbor, Mich.
LUNAR NAVIGATION STUDY, VOLUME 2 Final Report, Jan.–Dec. 1966
J. T. Broadbent, R. B. Odden, T. T. Trexler, and J. J. Very Dec. 1966 555 p
(Contract NAS8-20322)
(NASA-CR-93473; BSR-1472, V. 2) CFSTI: HC $3.00/MF $0.65 CSCL 22D

Procedures are given for the utilization of various performance data in the mission phase, exploration system phase, and navigation system phase of a simulated lunar roving vehicle mission. Position fix navigational components are analyzed in terms of critical mission parameters that affect the magnitude of the position error ellipse, or the heading error. The dead reckoning component is evaluated over the ensemble of lunar surface trajectories and associated critical parameters of lunar surface missions. Input error vectors for the position fix and dead reckoning components are identified, and elements of the error vectors, exercised over the range of mission parameters, are transformed by error models to derive both component and concept performance data. E.J.S.

N68-19470*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
SPECTROSCOPIC STUDY OF THE GAS CAP RADIATION INTENSITY FOR SIMULATED MARTIAN ATMOSPHERIC PROBES
Warren Winovich and Paul A. Croce [1966] 47 p refs Presented at the Symp. on Interdisciplinary Aspects of Radiative Energy Transfer, Philadelphia, Pa., 22–26 Feb. 1966
(NASA-TM-X-57250) CFSTI: HC $3.00/MF $0.65 CSCL 22A

A plasma tunnel study was made of gas cap and ablation products radiation from a flat faced cylindrical nose with a conical afterbody in a simulated Martian atmosphere of CO_2–N_2–Ar gas mixtures. A good understanding of the radiation from the gas mixtures was obtained. Tests approaching equilibrium conditions in the gas cap agree with theory, suggesting that CN violet radiation may be an important tool for probing distant planetary atmospheres with CO_2 and N_2 as constituents. Ablative heat shield materials substantially alter the total radiation. Albation ejecta can increase the observed intensities of the CN violet system by as much as a factor of 4, depending on the free stream density at the time of measurement. Atmospheric probes should incorporate heat sink shields to prevent gas cap contamination with ablation vapors. Proper scaling of density and body radius is required to simulate radiative intensities for planetary entries where peak heating rates are low. Nonequilibrium concentrations of molecules at low densities also alter the emitted radiation. R.N.A.

31 SPACE VEHICLES

Includes launch vehicles; manned space capsules; clustered and multistage rockets; satellites; sounding rockets and probes; and operating problems. For basic research see: 30 Space Sciences. For related information see also: 28 Propulsion Systems; and 32 Structural Mechanics.

N68-18494# National Research Council of Canada, Ottawa (Ontario). Space Research Facilities Branch.
BLACK BRANT ROCKETS AKF-3-26 AND AKF-3-27 LAUNCHED AT RESOLUTE BAY, OCTOBER 1967
Jan. 1968 36 p ref
(SRFB-009) CFSTI: HC $3.00/MF $0.65

This report deals with the engineering aspects of preparing the payloads and the launching of Black Brant rockets AKF-III-26 and AKF-III-27. Vehicles carried cosmic X-ray, plasma probe and differential absorption experiments to heights of approximately 100 miles to make measurements under geophysically calm atmospheric conditions. This was the second occasion that Black Brant rockets were flown at this remote launch site. Author

N68-18615*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
COMPUTING PROGRAM FOR AXIAL DISTRIBUTION OF AERODYNAMIC NORMAL-FORCE CHARACTERISTICS FOR AXISYMMETRIC MULTISTAGE LAUNCH VEHICLES
Ragan B. Madden Washington Mar. 1968 126 p refs
(NASA-TN-D-4342) CFSTI: HC $3.00/MF $0.65 CSCL 22D

This report describes a digital computer program which calculates the axial distribution of aerodynamic normal-force characteristics for axisymmetric, multistage launch vehicles in the linear angle-of-attack range. In calculating these characteristics for a particular configuration the program utilizes available experimental data. These data cover a wide range of Mach numbers and geometric parameters and can be readily utilized to obtain similar characteristics for most launch-vehicle configurations. Author

N68-18654*# Hughes Aircraft Co., El Segundo, Calif. Space Systems Div.
SURVEYOR SPACECRAFT SYSTEM: SURVEYOR 1 FLIGHT PERFORMANCE, VOLUME 1 Final Report
J. D. Cloud, K. C. Beall, and R. H. Leuschner Oct. 1966 430 p refs Prepared for JPL
(Contracts NAS7-100; JPL-950056)
(NASA-CR-93493; SSD-68189R, V. 1) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The actual performance of the Surveyor 1 spacecraft throughout the entire lunar mission is described, and compared with that predicted by the spacecraft design. The vehicle design is described and the mission objectives are delineated. A mission performance summary is presented covering the period of prelaunch countdown, the transit and landing phase, and the first lunar day of operations through to the day/night terminator. Tables are presented which summarize the performance parameters that could be determined through postmission analysis of spacecraft telemetry data. Also included for comparison purposes are the required or predicted values for these parameters. Operational and procedural recommendations are made for improvements in spacecraft design, postmission data processing, and test and performance prediction models. In order to set the stage for the detailed analyses of each spacecraft subsystem, the operation of the entire spacecraft as a system is discussed. Mission statistics are given, along with a performance analysis of the thermal subsystems. B.S.D.

N68-18655*# Hughes Aircraft Co., El Segundo, Calif. Space Systems Div.
SURVEYOR SPACECRAFT SYSTEM: SURVEYOR 1 FLIGHT PERFORMANCE, VOLUME 2 Final Report
J. D. Cloud, K. C. Beall, and R. H. Leuschner Oct. 1966 390 p refs Prepared for JPL
(Contracts NAS7-100; JPL-950056)
(NASA-CR-93491; SSD-68222R, V. 2) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Detailed performance analyses are presented on the electrical power (EP) subsystem, RF data link subsystem, signal processing systems, and flight control systems for the Surveyor 1 spacecraft. In evaluating the EP, consideration is given to the efficiencies of the regulators, total energy generated via the solar panels, and energy dissipated during the transit period of flight. An analysis of specific loads, comparison with prediction, and explanation of discrepancies are also included. The data link subsystem which consists of the transmitters, transponders, receivers, command decoders, and antennas is described, and the functions of this subsystem are delineated. An assessment is also made of the signal processing system which is composed of (1) engineering signal processor, (2) auxiliary engineering signal processor, (3) central signal processor, (4) signal processing auxiliary, and (5) low data rate auxiliary. The flight control system was analyzed in relation to attitude control, accurate angular maneuvers, precision velocity corrections, and soft lunar landing. The various components of the system and functions of each are presented. B.S.D.

N68-18656*# Hughes Aircraft Co., El Segundo, Calif. Space Systems Div.

SURVEYOR SPACECRAFT SYSTEM: SURVEYOR 1 FLIGHT PERFORMANCE, VOLUME 3 Final Report

J. D. Cloud, K. C. Beall, and R. H. Leuschner Oct. 1966 317 p refs Prepared for JPL

(Contracts NAS7-100; JPL-950056)

(NASA-CR-93494; SSD-68223R, V. 3) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Detailed data are presented on the performance analyses conducted on the various subsystems of the Surveyor 1 spacecraft. The subsystems considered include (1) the vernier propulsion system which is a variable thrust, liquid rocket system utilizing a 90% nitrogen tetroxide and 10% nitric oxide oxidizer, (2) the main retro-rocket which performs the major portion of the deceleration of the spacecraft during terminal descent, (3) the altitude marking radar, (4) the radar altimeter and doppler velocity sensor system which is an integrated radar system that measures slant range to lunar surface, (5) the landing gear, (6) the spacecraft television system, and (7) the spacecraft mechanisms including landing gear deployment, omnidirectional antenna deployment, and antenna solar panel positioner. A trajectory analysis is also presented along with terminal descent trajectory performance. Reliability is discussed in terms of relevant failures and unit operating experience. B.S.D.

N68-18657*# Hughes Aircraft Co., El Segundo, Calif. Space Systems Div.

SURVEYOR SPACECRAFT SYSTEM: SURVEYOR 2 FLIGHT PERFORMANCE Final Report

J. D. Cloud, T. B. Van Horn, and R. H. Leuschner Jan. 1967 565 p refs Prepared for JPL

(Contracts NAS7-100; JPL-950056)

(NASA-CR-93490; SSD-68189-2R) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Performance of Surveyor 2 spacecraft is documented throughout its mission and compared with that predicted by spacecraft design, with special attention given to the anomaly that caused mission failure. The system performance analysis includes an events summary and command log; prelaunch countdown; launch, injection, and separation data; midcourse and post midcourse information; and reliability analysis. Performance analyses are presented for the thermal control, electrical power, RF data link, vernier propulsion, and mechanisms subsystems; and signal processing and flight control data are also reported. Overall performance of the spacecraft was found to be excellent in the early stages of flight; but, during the midcourse velocity correction sequence, vernier engine 3 did not respond properly and spacecraft tumbling resulted that could not be corrected. Communication with the spacecraft was lost approximately 45 hr after launch when the main retro engine was fired. M.W.R.

N68-18658*# Hughes Aircraft Co., El Segundo, Calif. Space Systems Div.

SURVEYOR SPACECRAFT SYSTEM: SURVEYOR 3 FLIGHT PERFORMANCE Final Report

J. D. Cloud, T. B. Van Horne, and R. H. Leuschner Jul. 1967 563 p refs Prepared for JPL

(Contracts NAS7-100; JPL-950056)

(NASA-CR-93492; SSD-68189-3) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Real time and postmission data are used to analyze the performance of Surveyor 3 spacecraft, which was launched into a temporary parking orbit and then into a nearly perfect translunar trajectory by the Atlas Centaur launch vehicle. Television camera operations and diggings with the soil mechanics/surface sample were performed, although telemetry was impaired during the second touchdown. A general mission summary is included, along with Surveyor 3 reliability estimates and future reliability predictions. Details for the performance of the various subsystems are presented, including thermal control, electrical power, RF data link, vernier engine, signal processing, flight control, main retro propulsion, and altitude marking radar. The radar altimeter and doppler velocity sensor performance is reported, along with data on the crosscoupled side lobes, a plasma and sparking analysis, and KPSM arcing analysis. Structures and terminal descent trajectory performance, the mechanisms subsystem, television equipment, and the soil mechanics/surface sampler are also described. M.W.R.

N68-18659*# Hughes Aircraft Co., El Segundo, Calif. Space Systems Div.

SURVEYOR SPACECRAFT SYSTEM: SURVEYOR 4 FLIGHT PERFORMANCE Final Report

J. D. Cloud, T. B. Van Horne, and R. H. Leuschner Sep. 1967 394 p refs Prepared for JPL

(Contracts NAS7-100; JPL-950056)

(NASA-CR-93487; SSD-68189-4) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Performance of the Surveyor 4 spacecraft, which was injected into its transluner trajectory by a single burn Centaur launch vehicle, is reported and compared with predictions from spacecraft design. Spacecraft operations were performed according to plans with no significant anomalies until a sudden loss of signal near the end of the retro burn period, after which contact with the spacecraft was never regained. Based on both real time and postmission data, the report includes an overall system analysis and detailed subsystem performance data. Because of the abrupt loss of telemetry during the retro phase, Surveyor 4 did not accomplish its soft landing on the moon. M.W.R.

N68-18660*# Hughes Aircraft Co., Culver City, Calif. Space Systems Div.

SURVEYOR SPACECRAFT SYSTEM: SURVEYOR 5 FLIGHT PERFORMANCE Final Report

J. D. Cloud, T. B. Van Horne, and W. B. McIntyre Nov. 1967 543 p refs Prepared for JPL

(Contracts NAS7-100; JPL-950056)

(NASA-CR-93488; SSD-68189-5) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Subsystem performance analyses are reported for the Surveyor 5 spacecraft, which made a soft landing east of the center of the moon at an approach angle of 46.8 degrees. More than 19,000 TV pictures were taken and 93.5 hr were accumulated by the alpha scattering device to perform a compositional analysis of the lunar surface. Based on both real time and postmission data, performance details are presented for the alpha scattering device and other systems. Appendices to the performance analysis of the thermal control subsystem give transit and lunar day temperature plots. Analyses are included for the electrical and RF data link subsystems; and for signal processing, flight control, and vernier

propulsion. Helium regulator failure and corrective action is discussed for the last. Main retro propulsion, altitude marking radar, and radio altimeter and doppler velocity sensor performance were analyzed; as were the structures performance, mechanisms subsystems, terminal descent trajectory performance, and television equipment. M.W.R.

N68-18661*# Hughes Aircraft Co., El Segundo, Calif. Space Systems Div.
SURVEYOR SPACECRAFT SYSTEM: SURVEYOR 6 FLIGHT PERFORMANCE Final Report
J. D. Cloud, T. B. Van Horne, and W. B. McIntyre Jan. 1968 414 p refs Prepared for JPL
(Contracts NAS7-100; JPL-950056)
(NASA-CR-93495; SSD-68189-6) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Surveyor 6 performance from launch throughout its soft landing activities is documented, and performance activities are compared with those predicted from space design. Over 30,000 TV pictures of the moon were taken, and approximately 59 hr were accumulated by the alpha scattering device. The first powered flight translation of a Surveyor spacecraft was accomplished, with more than 10,000 of the TV pictures taken from the post-translation position. An overall system performance analysis includes data on the mission and its reliability; and detailed performance analyses are included for the various subsystems of the spacecraft. A first lunar day vernier system pressure loss study is appended to the performance analysis of the vernier propulsion subsystem. M.W.R.

N68-18662*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
REUSABLE AEROSPACE PASSENGER TRANSPORT: STUDY OF INCREMENTAL DEVELOPMENT APPROACHES Summary Report
Dietrich W. Fellenz 15 Apr. 1967 21 p refs
(NASA-TM-X-53595) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Studies were made of economical orbital transportation systems, in particular, possible options for time-phases and incremental development of such systems. Results showed that incremental development is a practical way for development of an economic logistics system, minimizing development risk and annual funding, and offering planning flexibility at only a nominal penalty in total systems cost. The most promising first development appears to be that of a reusable payload carrier with a capacity of 9 to 12 passengers. Systems comparisons show that, for the foreseeable variations of the mission market, a partially reusable concept could bring about most of the program savings that can be expected from reusability at moderate development risk and funding rate. A further development leading to a fully reusable system has high risk and uncertain payoff. Conceivably, at that time, a more advanced concept might be introduced. Author

N68-18704*# Schjeldahl (G. T.) Co., Northfield, Minn.
DEVELOPMENT OF A 425-FOOT DIAMETER PASSIVE COMMUNICATIONS SATELLITE WITH SELF ERECTING PROPERTIES Final Report
William Jacobi [1966] 138 p
(Contract NAS5-3943)
(NASA-CR-93423) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Research designed to develop a material with an improved ratio of radar cross-section to unit weight over ECHO II material is reported. The material was primarily intended to be used in a passive communication satellite of reduced cost and increased reliability. An open leno weave of fiberglass coated with copper was developed which would make a 425 foot diameter sphere weigh 2600 pounds. Preliminary tests show it to be radio reflective through 4 GHz. Small model cylinders and flat plates of this material erected without inflation aids, but small model spheres did not erect fully. A design for an erection aid showed promise, but could not be fully tested within the scope of the contract. Additional work on these concepts is recommended to fully establish the parameters of the material. Author

N68-18743*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
MARINER-MARS 1964 Final Project Report
Washington NASA 1967 356 p refs
(NASA-SP-139) GPO: HC $2.50; CFSTI: MF $0.65 CSCL 22B

This report presents the story of the Mariner-Mars 1964 project from the time of its inception until October 1, 1965, when two-way communications with the spacecraft were interrupted. By this date, the objectives of the project had been completed. However, since that time, spacecraft continued to function properly and a follow on project, called Mariner 4, was established to continue operations with the spacecraft through 1966 and 1967. Plans for tracking Mariner 4 in its path around the sun and for obtaining additional telemetry data, as discussed in this report, were successfully culminated during this follow on project. Author

N68-18810*# Westinghouse Electric Corp., Baltimore, Md. Aerospace Div.
FEASIBILITY AND PARAMETRIC DESIGN STUDY OF THE APPLICATION OF A STATION-KEEPING SYSTEM TO PASSIVE COMMUNICATIONS SATELLITES, PHASE 4 Final Report
Jan. 1965 183 p refs
(Contract NAS1-3131)
(NASA-CR-66575; Rept.-1779C) CFSTI: HC $3.00/MF $0.65 CSCL 22C

The feasibility of exploiting solar energy is assessed as a means of providing station-keeping or orbit position control to passive communications satellites. Two final configurations are presented, and their performance characteristics are analyzed. One configuration is predicated on the use of an optically transparent, but RF reflective lens material, with sails added to provide orbit position control. The other uses an optically opaque lens material, with orbit position control achieved by applying a pattern of different surface treatments or coatings to the lens material. Details are given on the attitude control and stabilization methods which are the same for each configuration. Dimensionally the two configurations differ slightly to provide the gravity gradient constraining torques required to resist the different solar disturbance torques produced on each body. The study was conducted at an altitude of 2000 nautical miles, but reasonable extrapolations show feasibility from 1000 to 6000 nautical miles. Results indicate the technical feasibility of employing orbit position by solar radiation to a gravity gradient stabilized passive communications satellite. M.G.J.

N68-18812*# Westinghouse Electric Corp., Baltimore, Md. Aerospace Div.
FEASIBILITY AND PARAMETRIC DESIGN STUDY OF THE APPLICATION OF A STATION-KEEPING SYSTEM TO PASSIVE COMMUNICATIONS SATELLITES, PHASE 2 Final Report
25 Jun. 1964 260 p refs
(Contract NAS1-3131)
(NASA-CR-66574; Rept.-1779A) CFSTI: HC $3.00/MF $0.65 CSCL 22B

A parametric study was conducted to produce design charts showing the effects and feasibility of variation of satellite diameter, orbit altitude, and inclination of the orbit. Total satellite weight is calculated, and the dependence of certain subsystem weights upon the weight of other subsystems is shown. Tables give the relative

weight penalty for varying altitude and inclination, and data plots depict the effect on total weight of varying the parameters. Attitude control studies show that system performance is most efficient at the 45° inclination, being degraded at both higher and lower inclinations and completely ineffective at 0°. General design parameters were determined for a vehicle to be used in an orbit position control flight experiment, that is compatible with the weight and volume capabilities of the Echo 2 canister and booster. Consideration is also given to the flight experiment control system, ground station functions, and instrumentation for attitude, power supply, temperature, and sphericity monitoring, data transmission, computation of attitude history, and control system fault isolation. M.G.J.

N68-18822*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

WATER PRESSURE AND ACCELERATIONS DURING LANDING OF A DYNAMIC MODEL OF THE APOLLO SPACECRAFT WITH A DEPLOYED-HEAT-SHIELD IMPACT-ATTENUATION SYSTEM

Sandy M. Stubbs. Washington, Mar. 1968. 48 p. refs. Film Supplement Number L-980 to this report is available on loan from NASA Langley Res. Center.

(NASA-TN-D-4275) CFSTI: HC $3.00/MF $0.65. CSCL 22B

An experimental investigation was made to determine impact water pressures, accelerations, and landing dynamics of a 1/4-scale model of the command module of the Apollo spacecraft with a deployed heat shield for impact attenuation. The landing system consisted of four vertically oriented hydraulic struts and six horizontally mounted strain straps. A scaled-stiffness aft heat shield was used on the model to simulate the structural deflections of the full-scale heat shield. Landings were made at simulated vertical parachute-letdown velocities of approximately 30 ft/sec (9.1 m/sec) full scale. Horizontal velocities from 0 to 50 ft/sec (15 m/sec), full scale, were tested, and the pitch attitudes ranged from −33° to 11°. Roll attitudes were 0° and 180°, and yaw attitude was 0°. Author

N68-18827*# North American Rockwell Corp., Downey, Calif. Space Div.

TECHNOLOGICAL REQUIREMENTS COMMON TO MANNED PLANETARY MISSIONS. APPENDIX A: MISSION REQUIREMENTS

R. D. Meston. Jan. 1968. 349 p. refs.

(Contract NAS2-3918)

(NASA-CR-73189; SD-67-621-2) CFSTI: HC $3.00/MF $0.65. CSCL 22B

The mission performance requirements for all mission objectives and mission modes considered in the study are presented. The mission objectives considered are: Mercury, Venus, Mars, Jupiter and its satellite Ganymede, and the asteroids Ceres and Vesta. The mission modes considered are direct transfers from Earth to the target body, direct returns, non-propulsive Venus swingby missions to and from Mars, propulsive swingby missions to and from Mercury, and flyby missions to Ceres, Vesta, and Jupiter. Mission opportunities which represent the extremes in the performance requirements are presented for each mission objective and mission mode considered in the study. Results of the aerobraking technology requirements study are also presented. The study defines the characteristics of the aerobraking entry corridors at Mars and Venus and the heat shield requirements for aerobraking spacecraft. The characteristic velocity requirements for manned landings on Mercury, Mars, Ganymede, and the asteroids Ceres and Vesta are also part of this study. Author

N68-18991*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

REDUCTION OF CONTROL SYSTEM DESIGN EFFORT

Jerome R. Redus. *In its* Astrodyn., Guidance and Control Rev. No. 1, 21 Feb. 1968, p. 35-38. (See N68-18983 09-30)

The rapid design of effective, reliable control systems is discussed in relation to the development of a semi-automatic, computer-oriented design procedure which would achieve as good performance as is possible within specified restrictions on the characteristics of the system. The three major problems in launch vehicle control system design are designated as (1) achieving satisfactory dynamic performance, (2) signal processing or filtering, and (3) accommodations of uncertainties in vehicle characteristics. The designing of a control system to have satisfactory dynamic response is discussed, and the techniques to determine the optimal linear control and statistical performance of the vehicle are assessed. Filter design techniques are summarized with respect to past and recent developments. The design of systems consciously insensitive to parameter variation is also mentioned. B.S.D.

N68-18992*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

LOAD RELIEF SYSTEMS FOR LAUNCH VEHICLES

John M. Livingston. *In its* Astrodyn., Guidance and Control Rev. No. 1, 21 Feb. 1968, p. 39-41. (See N68-18983 09-30)

For the purpose of delineating the problems involved in designing a load relief control system, a brief summary is presented on the function of a control system and the basis of its design. The vehicle's dynamic responses are discussed with emphasis on the interplay between the vehicle, disturbances, and control laws. The load relief control system is also discussed in relation to structural loading in the vehicle and a design that allows the vehicle to meet the mission requirements without structural modifications. B.S.D.

N68-19030*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

INITIAL RESULTS OF STUDIES OF HANDLING QUALITIES OF A SIMULATED LUNAR LANDING VEHICLE

Thomas C. O'Bryan [1966] 20 p. Presented at the SAE Comm. A-18 Meeting on Aerospace Vehicle Flight Control Systems, New Orleans, 19-21 Jan. 1966.

(NASA-TM-X-57213) CFSTI: HC $3.00/MF $0.65. CSCL 22B

The test facility at the Langley Research Center serves to simulate lunar environment for studying true vehicle dynamics during lunar landings. The facility consists of a manned, rocket-powered vehicle suspended by vertical cables from a traveling crane, supported by a gantry structure 250 ft high and 400 ft long. In addition to a description of the facility and the vehicle, this paper gives typical landing trajectories flown by test pilots, examples of throttle control, attitude control system parameters, and boundaries of translational velocity versus range resulting from the landing approaches. K.W.

N68-19085*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AN ANALYTICAL PROCEDURE FOR PREDICTING THE TWO-DIMENSIONAL IMPACT DYNAMICS OF SPACECRAFT LANDING GEAR

James T. Howlett. Washington, Mar. 1968. 42 p. refs.

(NASA-TN-D-4434) CFSTI: HC $3.00/MF $0.65. CSCL 22B

This paper presents a method for analyzing the dynamic behavior of two-dimensional impacting struts and trusses of the type presently used in the construction of landing gear for lunar landing vehicles. The struts and trusses may contain shock absorbers. The method uses lumped masses to represent the system, and two-dimensional motion is assumed. The equations of motion are numerically integrated to obtain response time histories of each of the mass points, and to allow detailed analysis of the dynamic behavior of the system. Application of the method to a particular strut

and truss indicates that axial elasticity is much more important than lateral elasticity in the dynamic behavoir. The present limitation of the method is the large amount of computer time required for problems in which the time period of interest is large compared with the period of the highest natural frequency of the system.
Author

N68-19095*# Boeing Co., Seattle, Wash. Space Div.
VOYAGER SPACECRAFT SYSTEM STUDY PHASE B, TASK D. VOLUME 1: SUMMARY REPORT Final Technical Report, 16 Jun.–16 Oct. 1967
Oct. 1967 74 p
(Contract NAS8-22602)
(NASA-CR-61660; D2-115002-1) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Mission objectives, and systems, analyses data are presented, as a basis for defining a spacecraft system concept that can meet the 1973 Mars mission/system requirements and constraints. Major subsystems concepts are listed, and a spacecraft functional description is given. Engineering drawings are presented to illustrate design concepts and various components and subsystems. The five engineering tasks discussed are (1) mission-dependent equipment definition, (2) Voyager program test flight, (3) science payload evolution considerations, (4) particulate contamination, and (5) photoimaging considerations. It is concluded that the 1973 Voyager Mars spacecraft will meet the specified requirements and constraints.
B.S.D.

N68-19096*# Boeing Co., Seattle, Wash.
VOYAGER SPACECRAFT SYSTEM STUDY PHASE B, TASK D. VOLUME 2: MISSION/SYSTEM REQUIREMENTS AND ANALYSES Final Technical Report, 16 Jun. –16 Oct. 1967
Oct. 1967 268 p
(Contract NAS8-22602)
(NASA-CR-93564; D2-115002-2) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The flight spacecraft for the 1973 mission is defined as a basis to establish applicable performance and design requirements that will allow maximum use of existing designs in lieu of new designs. The mission and system requirements for the Voyager Mars flight spacecraft design are delineated, and an assessment is made of the applicability of the 1971 spacecraft concepts to perform the 1973 mission. Results are presented on systems analysis and trade studies conducted on nine key systems: (1) trajectory selection, (2) launch delay, (3) mission energy balance, (4) encounter communication distance, (5) capsule–canister separation, (6) propulsion engine selection, (7) orbital data rate, (8) feasibility of laser telecommunication, and (9) RF high data rate study. A spacecraft definition summary is presented along with the preliminary requirements and concepts of operational support and mission dependent equipment. Potential logistics problems are considered. Test operational flows are reviewed in detail with particular attention given to the general areas of assembly and test, site support, and transportation.
B.S.D.

N68-19097*# Boeing Co., Seattle, Wash. Space Div.
VOYAGER SPACECRAFT SYSTEM STUDY PHASE B, TASK D. VOLUME 3: SPACECRAFT FUNCTIONAL DESCRIPTION Final Technical Report, 16 Jun.–16 Oct. 1967
Oct. 1967 365 p refs
(Contract NAS8-22602)
(NASA-CR-93559; D2-115002-3, V. 3) CFSTI: HC $3.00/MF $0.65 CSCL 22B

System level functional description is discussed in relation to standard trajectories and associated parameters necessary for design of the 1973 mission spacecraft and for consideration of the 1975, 1977, and 1979 opportunities are included. Guidence and navigation maneuver errors are defined. A nominal flight sequence has been developed. Spacecraft interfaces with the launch vehicle, capsule, and science system are defined. Based on the above, and on many trade studies, a spacecraft configuration is defined. System level considerations such as weight, reliability, electrical power, particulate contamination, and planetary quarantine are also included. Consideration is given subsystem functional description—each of the spacecraft subsystems were described in terms of design constraints and requirements, functions, performance and physical characteristics, interfaces, and reliability. Summaries of trade studies performed for subsystem selection are included. New technology and development, if required, are defined and scheduled for each subsystem. The growth potential of each subsystem is discussed.
Author

N68-19098*# Boeing Co., Seattle, Wash. Space Div.
VOYAGER SPACECRAFT SYSTEM STUDY PHASE B, TASK D. VOLUME 4: SELECTED ENGINEERING TASKS Final Technical Report
Oct. 1967 180 p
(Contract NAS8-22602)
(NASA-CR-93561; D2-115002-4, V. 4) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Consideration is given to the results of studies conducted on five selected engineering tasks. (1) The requirements imposed by the Voyager Mars 1973 post-injection mission operations on the mission-dependent equipment (MDE) are delineated, and the hardware and software that satisfy MDE requirements are given. The benefits of a test flight to the Voyager program, using the Saturn IB, are determined in terms of effect on ground testing, level of assurance provided, and effect on cost and facilities. (3) The primary objectives of the task on science payload evaluation are given, and secondary objectives of evaluating science data automation equipment are discussed. (4) Objectives of the particulate contamination task are the determination of the most reasonable level of particulate contamination control for the spacecraft and its subsystems, and impact of that level of control on required facilities. (5) The photoimaging concepts are discussed in relation to imaging system requirements and analysis, and description and comparison of candidate imaging systems.
B.S.D.

N68-19099*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
VOYAGER SPACECRAFT PHASE B, TASK D. VOLUME 4: ENGINEERING TASKS. BOOK 1: EFFECT OF CAPSULE RTG'S ON SPACECRAFT Final Report
16 Oct. 1967 109 p refs
(Contract NAS8-22603)
(NASA-CR-93563; DIN-67SD4379, V. 4, Bk. 1) CFSTI: HC $3.00/MF $0.65 CSCL 22B

As radioisotope thermoelectric generators (RTGs) are being considered for the prime power source in the Voyager surface laboratory system, the impact of the RTGs in the flight capsule upon the spacecraft was examined. In the planetary vehicle configuration selected, the major electronic equipment is located near the capsule interface so that it is subjected to the highest levels of thermal and nuclear radiation to permit worst case analysis. Separate cases of the spacecraft powered by solar or RTG power are considered. Prelaunch and ascent thermal conditions were analyzed, and analyses were also conducted on the RTG radiation environment, the radiation effects on various types of spacecraft equipment and photographic film, and the interaction of the RTG nuclear radiation with the science payload. An assessment of the missions effects show that the RTGs eliminate the capsule requirements for 200 watts of electrical power from the spacecraft. It is proposed that this excess power be used to improve performance, or as a backup source during spacecraft maneuvers.
M.G.J.

N68-19100*# General Electric Co., Philadelphia, Pa. Missile and Space Div.

VOYAGER SPACECRAFT PHASE B, TASK D. VOLUME 1: SUMMARY Final Report

16 Oct. 1967 78 p refs

(Contract NAS8-22603)

(NASA-CR-61661; DIN-67SD4379, V. 1) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Summary data are presented on the update and optimization of a preliminary spacecraft design for the Voyager 1973 mission, including adaptability and utilization growth to perform 1975, 1977, and 1979 Mars missions. Major improvements in science payload leading to increased data transmission capability and solar array power, modularity, reliability and adaptability to 1970 Mars missions are reported. The factors considered in developing the implementation plan are cited as the effect of the fixed launch data, the long life requirements, quarantine restrictions, program cost, maximum use of existing facilities, handling and transportation, and integration of the spacecraft with other Voyager systems. The preliminary plans indicate the schedule requirements for a 1973 mission can be maintained. Engineering studies showed the technical feasibility of applying radioisotope thermoelectric generators in the 1975 Voyager surface laboratory system, and of using significant portions of the Apollo checkout equipment-S/C. Findings are also reported on the central computer, atmosphere definition, and photoimaging studies. M.G.J.

N68-19101*# General Electric Co., Philadelphia, Pa. Missile and Space Div.

VOYAGER SPACECRAFT PHASE B, TASK D. VOLUME 2: SYSTEM DESCRIPTION. BOOK 1: GUIDELINES AND STUDY APPROACH, SYSTEM FUNCTIONAL DESCRIPTION Final Report

16 Oct. 1967 411 p refs

(Contract NAS8-22603)

(NASA-CR-93550; DIN-67SD4379, V. 2, Bk. 1) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Design details and functional requirements are presented on the Voyager spacecraft, which consists of two planetary vehicles launched on a Saturn 5 and separated from the S-4B stage after injection into an Earth-to-Mars transfer trajectory. Each vehicle, which operates independently after separation, is composed of a flight spacecraft and a flight capsule with the capsule separating from the flight spacecraft within 30 days after the planetary vehicle is placed into an orbit about Mars. Optimization studies to select a preferred configuration are discussed, and functional system integration is described. Consideration is also given to the selection of a hypothetical baseline scientific payload and the requirements which it imposes on spacecraft design. The capsule, launch vehicle, and launch operation system interfaces, and the mission operations system and Deep Space Network interface, are examined. Trajectory and guidance analysis results are given, and systems analyses and trade studies data are provided on transmitter power–antenna gain, spacecraft propulsion fourth staging, planetary quarantine, and the auxiliary thruster. Reliability analyses methodology is outlined. M.G.J.

N68-19102*# General Electric Co., Philadelphia, Pa. Missile and Space Div.

VOYAGER SPACECRAFT PHASE B, TASK D. VOLUME 2: SYSTEM DESCRIPTION. BOOK 2: TELECOMMUNICATION Final Report

16 Oct. 1967 542 p refs

(Contract NAS8-22603)

(NASA-CR-93552; DIN-67SD4379, V. 2, Bk. 2) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Summary data are presented on the selected 1973 Voyager flight spacecraft telecommunication system, and the requirements placed on the subsystems, the operation during a typical mission, and the performance parameters are given. Graphs of the telemetry, tracking, command, and ranging performance are included. The radio subsystem configuration is described, expected performance is indicated, and subsystem interfaces with other spacecraft elements are defined. The major requirements for the command subsystem are cited, the baseline design is described, and the interfaces, performance, and physical characteristics are examined. Functional descriptions, interface characteristics, and performance parameters are also given on the telemetry, data storage, and data automation subsystems. M.G.J.

N68-19103*# General Electric Co., Philadelphia, Pa. Missile and Space Div.

VOYAGER SPACECRAFT PHASE B, TASK D. VOLUME 2: SYSTEM DESCRIPTION. BOOK 3: GUIDANCE AND CONTROL, COMPUTER AND SEQUENCER, POWER SUBSYSTEM, ELECTRICAL SYSTEM Final Report

16 Oct. 1967 377 p refs

(Contract NAS8-22603)

(NASA-CR-93539; DIN-67SD4379, V. 2, Bk. 3) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The baseline designs of several subsystems are described, and the alternates that were considered in arriving at the selected designs are discussed. Details are given on the attitude control, cold gas jet, and autopilot subsystems that comprise Voyager guidance and control and maintain spatial attitude during cruise, maneuver, guidance correction, and orbital phases. Propellant sloshing is considered, and a mathematical formula is derived on the motion of a cavity in a spherical or circular cylindrical tank at very low gravity. A multimass model is presented for studying propellant motion at near zero bond numbers in a spherical tank. Functional requirements are defined for the computer and sequencer, which is a cycled, special purpose digital computer for generating and distributing onboard commands. The baseline power subsystem is described, the solar array output is calculated, and solar array and battery size requirements are determined. Details are also provided on the electrical system which provides the electrical interfaces and connections between the power supply and the spacecraft subsystems. M.G.J.

N68-19104*# General Electric Co., Philadelphia, Pa. Missile and Space Div.

VOYAGER SPACECRAFT PHASE B, TASK D. VOLUME 2: SYSTEM DESCRIPTION. BOOK 4: ENGINEERING MECHANICS, PROPULSION, PLANET SCAN PLATFORM Final Report

16 Oct. 1967 448 p refs

(Contract NAS8-22603)

(NASA-CR-93562; DIN-67SD4379, V. 2, Bk. 4) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The preliminary structural design features of the baseline spacecraft are presented, and some of the structural trade-offs are described. Micrometeoroid protection criteria are defined, and the results of separation and clearance analyses are presented. Details are given on the thermal control subsystem, consisting of insulation, thermal coatings, louvers, heaters, and control of structural features to provide desired heat transfer paths. Alternatives are assessed, and spacecraft temperatures during all mission phases are analyzed. A functional description is given on the mechanism subsystem which includes high gain antenna deployment and gimbal actuation, planetary scan platform (PSP) deployment, thrust vector control actuators, and other deployment mechanisms. The planetary vehicle separation system is described, along with the explosive devices used to initiate and accomplish pyrotechnic events. Design details are included on the propulsion subsystem using the lunar module descent engine, and on the PSP whose function is to protect, environmentally control, and support the Mars-oriented science sensors. M.G.J.

N68-19105*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
VOYAGER SPACECRAFT PHASE B, TASK D. VOLUME 2: SYSTEM DESCRIPTION. BOOK 5 Final Report
16 Oct. 1967 167 p refs
(Contract NAS8-22603)
(NASA-CR-93558; DIN-67SD4379, V. 2, Bk. 5) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Some limited areas of design standards to be applied to the Voyager spacecraft are discussed, based on a review of the standardized approach to packaging the electronic equipment and of the preferred parts and materials lists. Operational support equipment (OSE) requirements are analyzed, and the results of a checkout system conceptual trade study are reported. Three configurations of the OSE are considered: the bench test equipment required to support module assembly and subsystem testing; system test equipment required to support subsystem integration during final assembly, and system tests at the factory and at Kennedy Space Center; and launch complex equipment required to support prelaunch and launch operations with the spacecraft mounted on the launch vehicle. Several OSE concepts are evaluated, and a preferred approach is selected. Ground mission assembly, handling, and shipping equipment requirements are defined. Space flight operations are also analyzed, along with the capabilities of the Deep Space Network to define probable requirements for mission-dependent hardware and software to support the mission.
M.G.J.

N68-19111*# National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, Fla.
ATLAS/AGENA-25 APPLICATIONS TECHNOLOGY SATELLITE C OPERATIONS SUMMARY
26 Oct. 1967 33 p
(NASA-TM-X-60905; TR-588) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The Applications Technology Satellite-3 mission objectives are discussed, the Atlas/Agena launch vehicle and the satellite are described, and the mission plan and post-inject operations are outlined. The launch operation plane includes descriptions of the ground facilities, data acquisition equipment, and meteorological services. Also described are the communications facilities to be used for prelaunch and early postlaunch operations. The Atlas/Agena and spacecraft operations to be performed during the launch countdown are listed.
R.N.A.

N68-19142*# Boeing Co., Seattle, Wash. Aerospace Group.
INTEGRATED MANNED INTERPLANETARY SPACECRAFT CONCEPT DEFINITION. VOLUME 2: SYSTEM ASSESSMENT AND SENSITIVITIES Final Report
Jan. 1968 192 p refs
(Contract NAS1-6774)
(NASA-CR-66559; D2-113544-2, V. 2) CFSTI: HC $3.00/MF $0.65 CSCL 22B

This study considered a manned planetary system with a high degree of flexibility for accomplishing missions to both Mars and Venus in the majority of launch opportunities is designed for use as a handbook by the planners of future manned planetary missions, and is divided into three parts: the first part gives a brief description of the overall requirements and the recommended system; the second part assesses how well the system satisfies the requirements; the third part assesses sensitivities of the reccommended system to changes. This assessment of sensitivities answers what if' questions in three major categories: (1) what will happen if the mission requirements and parameters change? (2) what will happen if design requirements change or if good alternates are selected? and (3) what will happen if schedules, costs, or program plans change? Part 3 also predicts the system's growth capability and applicability to other space programs, identifies its technology implications, assesses its impact on precursor probes and Earth-orbital space stations, and contains "what if" thoughts that appear answerable but are outside the scope of the study.
Author

N68-19151*# TRW Systems Group, Redondo Beach, Calif. Voyager Operations Space Vehicles Div.
VOYAGER SPACECRAFT PHASE B, TASK D. VOLUME 1: SUMMARY Final Report
Oct. 1967 56 p refs
(Contract NAS8-22604)
(NASA-CR-61662) CFSTI: HC $3.00/MF $0.65 CSCL 22B

A recommended configuration is defined for a Voyager spacecraft that can be used efficiently for the Martian launch opportunities from 1973 to 1979 without hardware modification. Weight analyses are preesnted for Case A, which calls for a 5000-pound capsule for all four mission years; and for Case B, which specifies a 6000-pound capsule in 1973, and a 7000-pound capsule in 1975, 1977, and 1979. In the configuration, the modular approach is incorporated at the level both of the three major spacecraft modules and at the level of subsystems. Propulsion tanks, identical for all mission years, are sized to hold 16,000 pounds of propellant in keeping with the greatest propellant loading anticipated. Charts illustrate the type of performance margins available. The recommended configuration provides modularity, good load paths, fixed solar cell panels, and convenient, structurally-sound mounting and control of appendages. The probability that one of the two tandem-launched planetary vehicles enters the desired orbit at Mars and completes all of its objectives in that orbit is calculated to be 90%.
M.G.J.

N68-19152*# TRW Systems Group, Redondo Beach, Calif. Space Vehicles Div.
VOYAGER SPACECRAFT PHASE B, TASK D. VOLUME 2: SPACECRAFT DESIGN AND PERFORMANCE Final Report
Oct. 1967 241 p refs
(Contract NAS8-22604)
(NASA-CR-93534) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The recommended configuration for the Voyager spacecraft is discussed in terms of the modular design approach, the interfaces, and the physical arrangement of the structure and equipment. Design criteria and operational capability are defined for the structural and mechanical systems, control of mass distribution, equipment mounting and accommodations, propulsion installation, thermal control configuration characteristics, guidance and control installation, and the electrical power configuration. The functions and relationships of various elements of the spacecraft which provide mission capability are discussed. The 1973 Voyager mission is defined, and the capabilities of the recommended configuration for performing this mission are assessed. The overall mission problem is formulated and the proposed design solution is verified. Consideration is given to interplanetary trajectories and Mars orbit capability, trajectory accuracy, planetary quarantine constraints, scientific mission objectives, communication performance, and probability of success. The applicability of the recommended design to the 1975, 1977, 1979 missions is shown.
M.G.J.

N68-19153*# TRW Systems Group, Redondo Beach, Calif. Space Vehicles Div.
VOYAGER SPACECRAFT PHASE B, TASK D. ANNEX TO VOLUME 2: SPACECRAFT DESIGN AND PERFORMANCE Final Report
Oct. 1967 539 p refs
(Contract NAS8-22604)
(NASA-CR-93554) CFSTI: HC $3.00/MF $0.65 CSCL 22B

In order to build a framework for the detailed flight sequence, the Voyager Mars mission is described. The related spacecraft operating modes for defining the mission and relating the

corresponding functional requirements to the detail subsystem design are discussed. Selected Mars orbit data calculated for specific possible 1973 missions are reported, along with appropriate launch-arrival dates and hyperbolic excess speeds at Mars encounter. A supporting analysis is provided for defining spacecraft performance in regard to structural reliability, propulsion system firing and vent sequences, and detailed temperature control reliability calculations. Tables are included listing failure rates and probability of success for Voyager subsystem equipment. Data are presented in tabular and graphic form on the mass and weight properties of the recommended spacecraft. Voyager spacecraft flight equipment is listed, and tabulated data on associated power, temperature limits, weight, and size parameters are given. B.S.D.

N68-19154*# TRW Systems Group, Redondo Beach, Calif. Space Vehicles Div.

VOYAGER SPACECRAFT PHASE B, TASK D. VOLUME 3: SPACECRAFT MECHANICAL SUBSYSTEMS DEFINITION Final Report

Oct. 1967 280 p refs

(Contract NAS8-22604)

(NASA-CR-93553) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Preliminary specifications and recommended configuration features are presented on (1) the structural subsystem which includes the basic framework of the spacecraft, and various support and release mechanisms for the spacecraft and its appendages; (2) the planetary vehicle adapter, consisting of the structure, cabling, and other hardware located between the planetary vehicle, inflight separation joint, and the associated points of attachment to the Voyager shroud; (3) the propulsion subsystem, which is designed around the lunar module descent engine; and (4) the temperature control subsystem, which makes use of multilayer insulations, high temperature insulations, louvers, special surface finishes, thermostatically controlled heaters, and varying degrees of structural cooling. Analytic data are presented on propellant settling time as a function of propellant tank accelerations, and the net transport of propellant across a screen due to a temperature gradient. The probability of Voyager propellant tank fracture by meteoroid impact is assessed, and the performance of low-thrust orbit insertion as a backup mode is examined to determine its suitability. M.G.J.

N68-19155*# TRW Systems, Redondo Beach, Calif. Space Vehicles Div.

VOYAGER SPACECRAFT PHASE B, TASK D. VOLUME 4: SPACECRAFT ELECTRICAL SUBSYSTEMS DEFINITION Final Report

Oct. 1967 301 p

(Contract NAS8-22604)

(NASA-CR-93549) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Functional descriptions and performance data are presented on the three groups of electrical subsystems in the recommended Voyager spacecraft configuration. These include: (1) the communication and data processing group consisting of the telemetry and data storage, S-band radio, and command subsystems; (2) the guidance and control subsystem for maintaining spacecraft attitude at all times, and the computer and sequencer for storing the programs for all modes of operation; and (3) the electrical systems integration group, comprising the electric power subsystem, and the electrical distribution and pyrotechnics subsystem for routing power and signals to the electrical subsystems, the propulsion module, and the adapter, for switching power, and for providing firing control for all ordnance devices. Subsystem components are described, and preliminary specifications are included. M.G.J.

N68-19156*# TRW Systems Group, Redondo Beach, Calif. Space Vehicles Div.

VOYAGER SPACECRAFT PHASE B, TASK D. ANNEX TO VOLUME 4: SPACECRAFT ELECTRICAL SUBSYSTEMS DEFINITION Final Report

Oct. 1967 232 p refs

(Contract NAS8-22604)

(NASA-CR-93528) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Analytical data and trade-off studies are presented to support the three groups of electrical subsystems proposed for the recommended Voyager spacecraft configuration. For the communication and data processing group, these pertain to modulation and coding, code reconstruction and direct turnaround methods of handling the ranging signal, antenna drive elements, and the command bit synchronizer. Guidance and control backup data relate to coast phase attitude control, powered flight control, C-1 engine control, inertial reference units, optical sensors, reaction control, engine actuator, digital control, centralized computer system, and science data automation equipment versus integrated computer and sequencer unit. In the area of electrical systems integration, the studies involve trade-offs on battery types, solar array and battery control, and pyrotechnic devices and techniques; ac versus dc distribution; and wiring integration design engineering. M.G.J.

N68-19157*# TRW Systems Group, Redondo Beach, Calif. Space Vehicles Div.

VOYAGER SPACECRAFT PHASE B, TASK D. VOLUME 5: SCIENCE PAYLOAD INTEGRATION Final Report

Oct. 1967 253 p refs

(Contract NAS8-22604)

(NASA-CR-93538) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The science objectives for Mars exploration are summarized, and a hypothetical payload is defined. This consists of core group of science experments used basically to determine Mars atmospheric constituents and surface temperatures, and includes a group of five television cameras. The detailed mechanical and electrical integration of this payload with the spacecraft is described. Preliminary specifications are given for the recommended film–TV photoimaging system, and its integration with the spacecraft is described. An additional 12 experiments are recommended for inclusion on the spacecraft as complements to the four core experiments. The integration of these additional experiments is described, and definitions are presented on the spacecraft subsystems configured to provide this growth capability. An augmented film–TV system to exploit the upgraded spacecraft is proposed. Also included are command and telemetry lists, science power estimates, science interface summaries, science interface wire estimates, weight estimates, and the control system design for the planetary scan platform. M.G.J.

N68-19158*# TRW Systems Group, Redondo Beach, Calif. Space Vehicles Div.

VOYAGER SPACECRAFT PHASE B, TASK D. VOLUME 6: DESIGN ALTERNATIVES AND GROWTH POTENTIAL Final Report

Oct. 1967 198 p

(Contract NAS8-22604)

(NASA-CR-93560) CFSTI: $3.00/MF $0.65 CSCL 22B

The rationale which led to the selection of the recommended Voyager spacecraft configuration is discussed, and a scaling model is developed covering variations in propellant capacity and increased (solid) payload. Alternate means of allocating and using performance margin are identified. Various combinations of launch period, orbit size, orbit rotation, and choics of arrival data are assessed, and candidate mission plans are defined. The results indicate that a usable propellant capacity of 16,000 pounds is appropriate for either Case A or B capsule weights, and that the spacecraft structure should be capable of accommodating capsules up to 8000 pounds. Design alternatives, independent of propellant and structure sizing, are considered, in order to varify that the recommended design provides the greatest system reliability. An upgraded spacecraft design concept is proposed to exploit the growth potential in the major

hardware items on the recommended spacecraft with minimal changes in the basic configuration. The scientific basis for upgrading mission and communications performance is indicated, and performance analyses are presented. M.G.J.

N68-19160*# TRW Systems Group, Redondo Beach, Calif. Space Vehicles Div.

VOYAGER SPACECRAFT PHASE B, TASK D. VOLUME 9: ENGINEERING STUDY TASK, ETO DECONTAMINATION Final Report

Oct. 1967 151 p refs

(Contract NAS8-22604)

(NASA-CR-93529) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The Martian planetary quarantine requirement for the Voyager program has led to the establishment of decontamination procedures based on the use of ethylene oxide-Freon 12 gas (ETO) as a biocidal agent. Effects of an ETO decontamination requirement have been evaluated, with emphasis on decontamination requirements from the biological viewpoint, spacecraft design variables, determination of a contamination control plan, selection of qualified materials and components for ETO exposure, the design and operational needs of specialized facilities and equipment, and the impact of a contamination control effort on overall program schedules. These collected data have been reduced to aid in defining the cumulative effect in terms of costs and implementation. Author

N68-19161*# TRW Systems Group, Redondo Beach, Calif. Voyager Operations Space Vehicles Div.

VOYAGER SPACECRAFT PHASE B, TASK D. VOLUME 10: ENGINEERING STUDY TASKS: SHROUD, TEMPERATURE CONTROL, PLUME HEATING Final Report

Oct. 1967 156 p refs

(Contract NAS8-22604)

(NASA-CR-93525) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Vent areas are recommended for the different elements of the configuration, based on allowable pressure differentials determined by strength and contamination considerations and using an assumed Saturn 5 ascent trajectory. Shroud separation planes were selected for the nose fairing and the shroud midsection. A set of separation velocities is suggested for each of the separating bodies, which will yield probabilities of collision less than 10^{-6}. The separation design concept includes sequence and timing of events, mode of separation, selection of separation planes, and the means of separating the various elements. An optimized temperature control subsystem was selected, based on a combination passive–active system using the totally insulated enclosure concept, thermal louvers, thermostatically controlled heaters, thermal finishes, and varying degrees of structural thermal coupling. Consideration is also given to lunar module descent engine plume heating and areas of impingement, and the effect on critical spacecraft components of radiation from the nozzle extension. Temperatures for the components, due to these effects, are given. M.G.J.

N68-19210*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

FLIGHT VIBRATION DATA OF ASTROBEE 1500, NASA FLIGHT 16.02 Final Report

Arney N. Munson Dec. 1967 81 p

(NASA-TM-X-63128; X-321-67-634) CFSTI: HC $3.00/MF $0.65 CSCL 22D

This report presents payload vibration data obtained during the launch of the two-stage Astrobee 1500 sounding rocket. Three channels of high-frequency vibration data were obtained from crystal accelerometers mounted on the payload support structure. High vibratory transient response levels were noted at first- and second-stage ignition and just after first-stage burnout. The former responses are typical of rocket engine ignition; however, the latter response is attributed to the anomalous release of the clam-shell heat shield. Relatively low level random responses, less than 1 g rms, were noted during the flight periods of transonic, maximum dynamic pressure, and shortly after second stage burnout. Also measured were rigid body coning motions that occurred at about T+98 seconds, 20 seconds after second stage burnout. This motion is thought to have been initiated by the unwrapping of the spun fiberglass motor case caused by high motor temperatures. Author

N68-19226*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

EVALUATION OF LATERAL-DIRECTIONAL HANDLING QUALITIES OF PILOTED REENTRY VEHICLES UTILIZING A FIXED BASE SIMULATION

Frank J. van Leynseele Washington Mar. 1968 34 p refs

(NASA-TN-D-4410) CFSTI: HC $3.00/MF $0.65 CSCL 22B

A simulator investigation was conducted to evaluate the lateral-directional handling qualities of piloted reentry vehicles. The lateral-directional parameters were chosen to represent a sample of dynamic characteristics typical of reentry-vehicle configurations. The evaluations were made by using a three-degree-of-freedom fixed-base simulator with a pseudo-outside world visual display (contact analog). The investigation showed that the pilots preferred the ratio of the roll transfer function numerator frequency to the Dutch roll frequency to be unity, independent of the magnitude of bank angle to sideslip angle ratio. They objected to an excessive amount of sideslip-angle excitation with ailerons when the ratio of the roll transfer function numerator frequency to the Dutch roll frequency differed from unity, the bank angle to sideslip angle ratio was low, and the yawing moment due to aileron was large. The evaluation also established that large rolling-motion excursions led to pilot miscoordination when the roll transfer function numerator frequency to Dutch roll frequency was larger than unity and the bank angle to sideslip angle ratio was large. A comparison of the results obtained with the three-degree-of-freedom contact-analog simulator and results obtained during a related study with a five-degree-of-freedom variable-stability T-33 airplane showed good correlation. Author

N68-19232*# Bellcomm, Inc., Washington, D. C.

A VENUS LANDER PROBE FOR MANNED FLYBY MISSIONS

P. L. Chandeysson 23 Feb. 1968 28 p refs

(Contract NASw-417)

(NASA-CR-93475; TR-68-710-3) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The Venus lander probe conceptual design is one of a group of instrumented unmanned vehicles which might be deployed from the manned flyby spacecraft shortly before planetary encounter. These probes would provide in situ and long term planetary measurements which cannot be made from the manned flyby spacecraft. The conceptual design was developed to determine how a Venus lander probe might operate on a manned flyby mission, what data it could contribute, and approximately how much it would weigh. The probe design includes a landing capsule which makes measurements on the surface of Venus and an entry spacecraft which transports the landing capsule through space and protects it during the high speed atmospheric entry. After entry, the capsule is separated from the entry spacecraft, and is fin stabilized during its fall to the surface. It lands on a crushable impact limiter which covers the lower half of the capsule. Protected by thermal insulation and cooled by melting ice, the capsule survives for about one hour on the surface and transmits data directly to the manned vehicle. Author

N68-19238*# Boeing Co., Seattle, Wash. Space Div.

INTEGRATED MANNED INTERPLANETARY SPACECRAFT CONCEPT DEFINITION. VOLUME 1: SUMMARY Final Report

Jan. 1968 49 p refs
(Contract NAS1-6774)
(NASA-CR-66558; D2-113544-1) CFSTI: HC $3.00/MF $0.65 CSCL 22B

This volume summarizes the Integrated Manned Interplanetary Concept Definition study. It recommends a common vehicle that is capable of accomplishing the majority of manned mission opportunities to orbit Venus and land on Mars over a Mars synodic cycle from 1975 to 1990. The recommended system is an all-nuclear space acceleration system and a basic spacecraft consisting of a biconic Earth entry module; a mission module which provides the living quarters, vehicle control, and experiment laboratories; and an Apollo-shaped Mars excursion module. The entire space vehicle is placed in Earth orbit by six launches of an uprated Saturn V launch vehicle which has four 156-inch solid rocket motors attached to the first stage. Author

N68-19245* Boeing Co., Seattle, Wash. Space Div.
APPLICATION OF MULTIVARIABLE SEARCH TECHNIQUES TO THE OPTIMAL DESIGN OF A HYPERSONIC CRUISE VEHICLE
D. S. Hague and C. R. Glatt [1967] 98 p refs
(Contract NAS2-4507)
(NASA-CR-73202) CSCL 22D

The present report describes the application of multivariable optimization techniques to the design of a hypersonic cruise vehicle. Described is a succession of design optimization studies and trades of increasing complexity. A series of one parameter optimization studies about a nominal point involving a single design variable is given along with a series of calculations involving twenty-eight vehicle and mission parameters. A variety of the nine district optimization techniques are employed in the studies. Some comparisons of the various methods are included and their relative efficiency assessed. For the optimal design problems considered here, the adaptive creeping technique, one of the most straightforward search algorithms, appears to provide a uniformly reliable and reasonably efficient method of solution. A brief description of the class of vehicles considered and the nominal point design is presented. Author

N68-19248*# Boeing Co., Seattle, Wash. Space Div.
INTEGRATED MANNED INTERPLANETARY SPACECRAFT CONCEPT DEFINITION. VOLUME 4: SYSTEM DEFINITION Final Report
Jan. 1968 56 p refs
(Contract NAS1-6774)
(NASA-CR-66562; D2-113544-4) CFSTI: HC $3.00/MF $0.65 CSCL 22B

This document defines the Interplanetary Mission System which consists of a spacecraft, space acceleration system, and Earth-based support. It includes a description of each element of the recommended system and alternates considered. System trades used in arriving at the recommended spacecraft and all-nuclear "common module" space acceleration system in combination with the Saturn V-25(S)U are presented. System capability with regard to Mars landing and Venus orbiter missions in the synodic cycle 1975 to 1990 is defined. Author

N68-19249*# Boeing Co., Seattle, Wash. Space Div.
INTEGRATED MANNED INTERPLANETARY SPACECRAFT CONCEPT DEFINITION. VOLUME 3: SYSTEM ANALYSIS. PART 2: EXPERIMENT PROGRAM Final Report
Jan. 1968 328 p refs
(Contract NAS1-6774)
(NASA-CR-66561; D2-113544-3-2) CFSTI: HC $3.00/MF $0.65 CSCL 22B

This document describes the rationale developed to select the scientific payloads for the manned planetary space program. The experiment program was based on a categorization of planetary observables into classes of information which could be analyzed in terms of their interrelationships and their predictability to permit a knowledge base projection into the 1975 to 1990 time period. The method of projection and the method of selecting the measurements and observations to be performed during the various phases of the mission are described. The document also describes the scientific payloads incorporated into the spacecraft designed during the Integrated Manned Interplanetary Spacecraft Concept Definition (IMISCD) study. The description is in terms of their design impact on the spacecraft as well as the measurements that they make in satisfying the objectives of the manned missions to Mars and Venus. Author

N68-19250*# McDonnell-Douglas Co., St. Louis, Mo.
MERCURY/GEMINI PROGRAM DESIGN SURVEY. NASA/ERC DESIGN CRITERIA PROGRAM STABILITY, GUIDANCE AND CONTROL
31 Jan. 1968 216 p refs
(Contract NAS12-586)
(NASA-CR-86041; F917) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Technical data has been assembled for Mercury and Gemini guidance and control equipment and their system integration to assist in the production of design criteria monographs that will facilitate unification of design approaches by NASA/ERC. The success of the Mercury and Gemini programs has been well documented, however, problems had to be overcome to achieve this success. This report documents significant problems, particularly those related to stability, guidance and control, and the evolution of equipment design. Author

N68-19275*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
VEHICLE ATTITUDE DETERMINATION WITH A SINGLE ONBOARD CAMERA
Richard J. Bendura, Allen B. Henning, and Robert E. Smith, Jr.
Mar. 1968 27 p refs
(NASA-TN-D-4359) CFSTI: HC $3.00/MF $0.65 CSCL 17G

Application of a postflight photographic method for determining the attitude history of a vehicle equipped with a single onboard camera is presented. Also included is an appendix showing the equation and geometric relationships of the method. For application, a minimum of two earth-related points need be identified on each photograph and the location of the vehicle with respect to the earth must be determined. In addition, the orientation of the camera axes system with respect to the vehicle is required. The method requires no other onboard instrumentation. The method was applied in determining the spacecraft attitude for a portion of the first flight test of the Planetary Entry Parachute Program (PEPP). The spacecraft was equipped with two relatively lightweight and inexpensive 16-mm motion picture cameras which photographed the surface of the earth. Data were obtained for altitudes ranging from 130,000 to 143,000 feet (40 to 44 kilometers). A comparison is made of the results independently obtained from each camera with ground based tracking data and with an azimuth datum point from an onboard magnetometer direction finding system. Author

32 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; thermal stress; impact phenomena; vibration; flutter; inflatable structures; and structural tests. For related information see also: 17 Materials, Metallic; and 18 Materials, Nonmetallic.

N68-18275# Navy Underwater Sound Lab., New London, Conn.
FLEXURAL VIBRATIONS OF BEAMS WITH FLEXIBLE BOUNDARY CONDITIONS
Charles L. LeBlanc 4 Dec. 1967 46 p refs
(USL-822; AD-664482)

Because of the modern trend toward low-frequency sound sources, flexural vibrators, in the form of beams and plates, are finding widespread use in sonar applications. In order to effectively use these vibrators as efficient and reliable transducers, it is essential that the structures be mechanically stable, necessitating the use of support mechanisms. Therefore, a theoretical investigation was undertaken to determine the effects of non-ideal support conditions on the flexural vibrations of beams. The fundamental resonance, the mode shape, the stress distribution, and the effective electromechanical coupling coefficient ratio, based on an energy distribution in the composite structure, are derived for a practical transducer configuration employing a lead zirconate titanate (PZT-4) ceramic body. Variations in these parameters are described in a general sense in terms of the dimensions and material constants of the central ceramic section of the beam. Author (TAB)

N68-18291# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
STABILITY ANALYSIS OF COMPLEX STRUCTURES USING DISCRETE ELEMENT TECHNIQUES
Janusz S. Przemieniecki 1967 45 p refs Presented at the Royal Aeron. Soc., Loughborough Univ. Technol., Symp. on Structural Stability and Optimization, 23–24 Mar. 1967
(AFIT-TR-67-7; AD-663919)

Stability analysis of structures idealized into an assembly of discrete elements is presented, using both the matrix displacement and matrix force methods. This analysis is particularly suitable in determining loading conditions for buckling of complex structures for which the conventional methods can not easily be applied. In the displacement method geometric stiffnesses are introduced to form the eigenvalue equations for buckling while in the force method the same equations are obtained by introducing fictitious forces and deformations on structural elements. A general method for determining geometric stiffnesses for arbitrary structural elements is derived. This method allows for a systematic inclusion of different nonlinear terms from the strain-displacement relations and is considerably simpler than the conventional techniques requiring the determination of strain energy. To demonstrate the method, geometric stiffnesses are derived for bars, beams, and triangular and rectangular plates with membrane stresses. A new geometric stiffness matrix for the rectangular plate element with bending deformations is also derived and the results are used to determine buckling stresses of flat rectangular plates with various aspect ratios and boundary conditions. Author (TAB)

N68-18309# National Technical Univ., Athens (Greece). Lab. for Testing Materials.
THE EFFECT OF TORSIONAL PRESTRAIN ON THE EMBRITTLEMENT OF MILD STEEL Final Technical Report, Jul. 1966–Jun. 1967
Pericles S. Theocaris Jun. 1967 24 p refs
(Contract DA-91-591-EUC-4085)
(AD-664598)

The paper presents the results of a series of tests on notched specimens made of low-carbon DIN 37 Steel, which were torsionally prestrained by different amounts at their plain or notched state and then tested in tension to failure. These tests showed the deleterious influence of pretwisting on the exhaustion of ductility of the metal. It was shown that the most effective mode for exhausting the ductility of the metal was achieved when pretwisted bars were sharpy notched and twisted, before fracturing in tension. Genuine brittle fractures occurring at a nominal stress lower than the virgin yield strength of the material were consistently produced in this manner. A series of plain torsion bars submitted to severe twisting, followed by a gradual reverse torsion, showed that the failure stresses of the subsequently sliced tension specimens passed through consecutive relative maxima and minima before reaching a maximum failure stress corresponding to an untwisting angle equal to the initial twisting. All fractures in these specimens were high stress failures. Author (TAB)

N68-18318# Pennsylvania State Univ., University Park. Dept. of Engineering Mechanics.
STRAIN-GRADIENT THEORIES OF MICROSTRUCTURE
T. D. Ralston and W. Jaunzemis 1967 53 p refs
(Contract AF 49(638)-1425)
(TR-1; AFOSR-68-0109; AD-664087)

The strain-gradient theories of Toupin and Mindlin are explored with a view to applications to periodic lattices and composite materials. The formulation of dynamic problems is dealt with in some detail. The resulting equations predict dispersion of plane waves, but it is not clear as yet whether it is versatile enough to predict all features of dispersion observed in lattices or composite materials. TAB

N68-18331# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CARRYING ABILITY OF A HOLLOW SPHERICAL SHELL, STRENGTHENED ALONG THE CONTOUR [NESUSHCHAYA SPOSOBNOST' POLOGOY SFERICHESKOY OBOLOCHKI, ZAKREPLENNOY PO KONTURU]
O. N. Shabiy 29 Aug. 1967 12 p refs Transl. into ENGLISH from Prikl. Mekhan. (USSR), v. 1, no. 11, 1965 p 7–11
(FTD-HT-66-584; AD-664074)

The limiting equilibrium of a sloping spherical shell is studied on the basis of the Tresk criterion and the associated law of flow. The shell considered here is circular in plan, edge-reinforced, and loaded by a uniformly distributed transverse loading. It is shown in Fig. 1, where the shell thickness is 2h, R is the radius of the shell in plan, and R2 is the radius of curvature. The loading intensity q (the maximum bearing capacity of the shell) is sought. It is assumed that: (1) deflections and deformations of the shell are small; (2) the Kirchoff-Lyav hypothesis is satisfied; (3) the shell material is elasto-plastic and in the limiting condition is threshold of loss of stability. A cylindrical coordinate system is adopted and dimensionless parameters describing displacements and rates of displacement under load are defined and incorporated into displacement equations. Plastic flow equations and equations for the location of the neutral surface of the shell are introduced. Annular and radial forces are defined and used in equations of equilibrium of a shell element. Integral formulae for force and moment intensities are introduced along with appropriate boundary conditions. The author derives an expression for a parameter defining the limiting load, and he describes the steps involved in solving for the parameter. Plots of the mutual variation of the limiting load and other parameters are shown. Author (TAB)

N68-18398# Aerospace Corp., San Bernardino, Calif.
PLASTIC BUCKLING OF ECCENTRICALLY STIFFENED CIRCULAR CYLINDRICAL SHELLS
Robert M. Jones Dec. 1967 49 p refs
(Contract F04695-67-C-0158)
(TR-0158(S3816-72)-1; SAMSO-TR-68-42; AD-664328)

A solution for the plastic buckling of eccentrically stiffened cylinders is derived by use of the J2 deformation theory of plasticity for a set of simply supported edge boundary conditions. The uniaxial character of the stiffeners and the stiffener eccentricity (asymmetry about the cylinder middle surface) are explicitly accounted for as is a variable Poissons ratio in the plastic region. A closed-form stability criterion is obtained for axial compression, lateral pressure, and hydrostatic pressure loadings. The present

results are more realistic for most practical stiffened cylinders than an existing solution in which an orthotropic shell model is used. A numerical example is given to illustrate the effect of plastic action on the buckling load of a typical aerospace structure. The FORTRAN IV computer program is described and listed.
Author (TAB)

N68-18450# Princeton Univ., N. J. Dept. of Aerospace and Mechanical Sciences.
THEORY OF MICROPOLAR ELASTICITY
A. Cemal Eringen Jun. 1967 194 p refs
(Contract N0014-67-A-0151-0004)
(TR-1; AD-664271)

The article presents a self-contained account of the recent theory of micropolar elasticity. Micropolar elastic materials possess extra independent degrees of freedom for the local rotations different from the rotations of the classical elasticity. These materials respond to spin inertia and body and surface couples, and as a consequence they exhibit certain new static and dynamic effects, e.g., new types of waves and couple stresses. Extensive discussions are presented on deformation, strain, microstrain, rotations, microrotations, kinematics, and balance laws. The thermodynamics of micropolar solids is formulated and the consequences of entropy and inequality are discussed. Field equations, boundary and initial conditions are obtained. The indeterminate couple stress theory is shown to result as a special case of the theory. Several static and dynamic problems are solved on the subjects of reflection of various types of micropolar waves, surface waves, stress concentration around a circular hole, and force and moment singularities in infinite solids.
Author (TAB)

N68-18464# Columbia Univ., New York. Dept. of Civil Engineering and Engineering Mechanics.
SECOND-ORDER EFFECTS IN SOLIDS AT SMALL STRAINS
A. M. Freudenthal and P. F. Gou Nov. 1967 87 p refs
(Contract Nonr-266(91))
(TR-48; AD-664308)

A new yield condition which provides for second-order effects in a perfect plastic material is introduced. An associated loading function for a strain-hardening material is proposed and a new material constant h is determined.
Author (TAB)

N68-18495*# Physics International Co., San Leandro, Calif.
PRESSURE MEASUREMENTS IN BASALT Final Report, 13 Jun. 1966–13 Feb. 1967
13 Feb. 1967 29 p refs
(Contract NAS5-9354)
(NASA-CR-93434) CFSTI: HC $3.00/MF $0.65 CSCL 20K

Experiments are reported in which manganin-wire piezoresistive pressure transducers have been imbedded in basalt rock and used to measure the pressure profiles resulting from the impact of hypervelocity projectilesz The experiments demonstrate the feasibility of making two-dimensional, non-perturbing, in-depth measurements of the pressure profiles resulting from such events. The gauges were imbedded in a thin layer of epoxy and sandwiched between two flat pieces of basalt. Explosively driven hypervelocity gas guns were used to accelerate the projectiles (lithium-manganin alloy) to a velocity of 4.6 km/sec. Good agreemant was obtained between the predicted peak pressure and that recorded by a manganin gauge located one-quarter of an inch below the impact surface, on the projectile axis.
Author

N68-18506# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. Dept. of Mechanics.
TEMPERATURE RISE AND STRESSES DUE TO INTERNAL HEATING
Peter J. Torvik Jan. 1968 20 p refs
(AFIT-TR-68-1; AD-664052)

A finite amount of heat is generated in each cycle when a material is subjected to a cycled load. This internal heat generation causes changes in the temperature of the body which, under certain conditions, may be appreciable. Expressions are developed for the temperature distribution and resulting thermal stress, and from them, the parameters which determine the magnitudes of temperature rise and stress are obtained. Qualitative agreement with previous experiments exists in the area of temperature rises. Thermal stresses are appreciable only in very unusual circumstances.
Author (TAB)

N68-18522 Washington Univ., Seattle.
STRESSES AND STRESS INTENSITY FACTORS FOR EMBEDDED HYPERBOLIC AND PARABOLIC CRACKS
Rameshchandra Chandulal Shah (Ph.D. Thesis) 1966 109 p
Available from Univ. Microfilms: HC $5.40/MF $3.00 Order No. 67-7676

The general objective of this work is to formulate a procedure of solving embedded crack problems by introducing appropriate systems of orthogonal curvilinear coordinates such that the two-sided plane crack surface be one of the coordinate surfaces. Crack surfaces considered are second degree surfaces such as the parabola and hyperbola. The Papkovitch–Neuber formulation is used to solve the equations of linear elasticity of three dimensions. Harmonic functions needed for finding stresses and displacements in a solid containing either a parabolic or hyperbolic crack subjected to uniform normal loading are obtained. Crack opening shapes for the parabolic and hyperbolic cracks are derived which are an elliptic paraboloid and a hyperboloid of one sheet, respectively. Stress intensity factors for the opening mode of fracture are derived for the parabolic as well as the hyperbolic crack from the displacement field and from stress equations. It is shown analytically that the dominant state of stress near the border of a general plane crack in the shape of ellipse, parabola or hyperbola is plane strain.
Dissert. Abstr.

N68-18564# Institut de Soudure, Paris (France).
STUDY OF WELDED JOINTS ON VERY THICK STEEL PLATES Special Report No. 2
Granjon, Videau, and Gaillard 15 Sep. 1967 48 p
(Contract EURATOM-007-64-TEEF(RD))
(EURAEC-1927; EUR-3754) CFSTI: HC $3.00/MF $0.65

The cooling behavior of two steels under the effect of welding thermal cycles was studied by in situ thermal analysis. Charpy Vimpact tests were also carried out. It was concluded that in the stress-relieved melted metal of a multi-pass weld, several families of specimens should be taken. The position of the notch in relation to the successive passes did not seem to have appreciable influence on the results. The weld zone showed great homogeneity to the impact strength test as regards the influence of specimen sampling direction.
NSA

N68-18626# State Univ. of New York at Buffalo. Div. of Interdisciplinary Studies and Research.
STRESS RELAXATION AT WAVE FRONTS IN ONE-DIMENSIONAL MEDIA DESCRIBED BY NONLINEAR VISCOELASTIC MODELS
R. P. Shaw and F. A. Cozzarelli Nov. 1967 33 p refs
(Contract Nonr-4449(00))
(Rept.-23; AD-664493)

Constitutive equations are presented for nonlinear viscoelastic materials under variable stress loading and are interpreted in terms of nonlinear viscoelastic models. Analytical solutions are obtained for stress, velocity and strain at the wave front in an impulsively loaded semi-infinite rod of material described by these nonlinear constitutive equations.
Author (TAB)

N68-18642# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

PROPAGATION OF ELASTIC-PLASTIC LOAD WAVE IN A ROD OF FINITE LENGTH

A. I. Buravtsev *In its* Herald of Leningrad Univ., Math., Mech. and Astronomy Ser., No. 1, 1967 27 Apr. 1967 p 97-106 refs (See N68-18631 09-19)

Previously derived partial differential equations describing the propagation of an elastoplastic wave in a bar of infinite length are solved under the assumption that deformations are small, and the effect of the rate of deformation on the shape of the stress-strain curve can be neglected. The results are applied to a bar of finite length, fixed at one end and acted upon on the free end by an axial impact which imparts a constant velocity and causes a deformation beyond the elastic range of the material. The spreading of the elastic (faster) and inelastic (slower) deformations, as well as the propagation and interaction of incident and reflected waves, are discussed. Equations for the motion parameters (movement, time, sound, velocity) are deduced for instants of each reflection of waves on both ends of the bar and in regions of wave interaction. These equations are unified by recurrence formulas, from which the deformation in an arbitrary cross section of the bar can be determined. In the case when the initial velocity of the free end of the bar after impact is given as a time-dependent function insuring the absence of an unloading wave, the interaction of the incident and reflected waves is described by the general equations. Author

N68-18649# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

OSCILLATIONS OF AN ASYMMETRIC BODY ON ELASTIC STRETCHING [KOLEBANIYA NESIMMETRICHNOGO TELA NA UPRUGIKH RASTYAZHKAKH]

S. A. Zegzhda *In its* Herald of Leningrad Univ., Math., Mech. and Astronomy Ser., No. 1, 1963 27 Apr. 1967 p 179-183 refs (See N68-18631 09-19)

Consideration is given to the oscillations of an elastically suspended body with one plane of symmetry for a circular motion of the base. It is assumed that the center of gravity lies on the line connecting the points of attachment of the suspensions to the body, and that the tension in the supports is large compared with the weight of the body. Assuming that the oscillations are small, a general solution of the Lagrange equation is derived, and formulas are obtained for the frequencies of the natural oscillations. These frequencies were checked experimentally and the agreement between the experimental and theoretical values was 8% on the average. Author

N68-18672# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ON THE THEORY OF SANDWICH TYPE SHELLS [K TEORII TREKHSLOYNYKH OBOLOCHEK S ZAPOLNITELYAMI]

B. G. Gazizov *In its* News of Inst. of Higher Learning. Aeron. Eng. 10 Apr. 1967 p 27-39 refs (See N68-18668 09-23)

The deformation of sandwich structures was studied analytically corresponding to three-layer isotropic shells in a Cartesian coordinate system. The principle radii of curvature are assumed to be the same for all three layers, and the deflection is assumed constant along the width of the sandwich shell. Furthermore, the tangential displacement along the filler and its adjacent supporting layer is assumed to vary according to a cubic parabola law. On the basis of these assumptions, expressions are derived for the shell displacement, deformation, stresses, and moments. In particular, "jump" conditions and their corresponding deformations are derived for the transitions between the displacements. From the equilibrium conditions on an element of the shell and with the aid of the above stress-strain relations, a pair of governing differential equations is obtained. Author

N68-18673# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

INVESTIGATION OF THE STABILITY OF THE SHELL OF AN AIR COOLED SLEEVE TYPE BYPASS BLADE [ISSLEDOVANIYE USTOYCHIVOSTI OBOLOCHKI GIL'ZOVOY DVUUHKONTURNOY LOPATKI VOZDUSHNOGO OKHLAZHDENIYA]

A. G. Zenukov *In its* News of Inst. of Higher Learning. Aeron. Eng. 10 Apr. 1967 p 41-52 refs (See N68-18668 09-23)

Stability of the cylindrical shells of a sleeve-type two-circuit turbine blade was investigated both theoretically and experimentally in order to determine performance and to develop a calculating method for determining the blade load-carrying capacity. The theoretical analysis was concerned with the effect of load variation along the blade's length on its stability. The experiments were conducted with cylindrical turbine blades 50-200 mm long, whose cross-section profiles were similar to the blade profile of the RD-20 aviation jet engine. Blades made of different materials were tested for stability under normal operating temperatures, under elevated temperatures up to 500-800°C, and under conditions of creep at 700°C. The results show that the load-carrying capacity of a blade is determined by the stability of the blade element with the smallest radius of curvature. Under elevated temperatures, the loss in stability is caused by the load approaching the yield strength of the blade material under tension. Under conditions of creep, the blades made of alloys with low ductility exhibit higher stability. A formula is derived for calculating critical stress in blades. Author

N68-18674# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ON THE QUESTION OF INCREASING THE VIBRATION STABILITY OF STRUCTURAL MEMBERS [K VOPROSU POVYSHENIYA VIBROUSTOYCHIVOSTI ELEMENTOV KONSTRUKTSII]

P. S. Skachkov *In its* News of Inst. of Higher Learning. Aeron. Eng. 10 Apr. 1967 p 53-61 refs (See N68-18668 09-23)

Experimental and analytical studies were made with shock absorption devices on composite elastic rods. The various sections are assumed to have different rigidities, and the rod is assumed to be in bending vibration under a kinematic, harmonic displacement. For simplicity, the amplitude of damped oscillations is studied for the first resonance only. The differential equations of bending vibrations are formulated, and the solution is carried out in the complex plane. A set of expressions is obtained which defines the amplitude, phase shift, and the shape of the elastic curve for the damped vibrations. The damping coefficient is determined from energy considerations. Numerical results are obtained for a special case corresponding to a rod of uniform as well as nonuniform mass distribution and various shock damper inputs, and the results are compared to experimental data. Author

N68-18676# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

TOWARDS THE DETERMINATION OF THE VELOCITY OF SOUND IN HYDRAULIC LINES OF COMPLEX CROSS SECTION [K OPREDELENIYU SKOROSTI ZVUKA V GIDROMAGISTRALYAKH SLOZHNOGO SECHENIYA]

V. F. Prisnyakov *In its* News of Inst. of Higher Learning. Aeron. Eng. 10 Apr. 1967 p 73-81 refs (See N68-18668 09-23)

An expression is formulated for the velocity of sound in liquids in a pipeline of a given cross section. This expression is then used to determine the velocity of sound in a slot between two fastened shells; in a hydraulic line having the shape of a spherical segment; and, in the case of a variable passage section area. E.J.S.

N68-18684# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

INVESTIGATION OF VIBRATIONS OF CANTILEVERED TRIANGULAR AND TRAPEZOIDAL PLATES BY THE RITZ METHOD [ISSLEDOVANIYE KOLEBANIY KONSOL'NYKH TREUGOL'NYKH I TRAPETSEVIDNYKH PLASTIN METODOM RITTSA]

G. A. Marchenko *In its* News of Inst. of Higher Learning. Aeron. Eng. 10 Apr. 1967 p 135–139 refs (See N68-18668 09-23)

The vibrations of cantilevered triangular and trapezoidal plates were studied analytically to simulate the behavior of lifting surfaces and rudders in flying vehicles. The total energy is written using the method of Ritz and the vibration is expressed as a sum of Legendre polynomials. A set of homogeneous, algebraic equations is obtained, and the solution given numerically on the Ural-2 computer for three types of cantilevered triangles. Author

N68-18685# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

SOME RESULTS OF AN EXPERIMENTAL INVESTIGATION OF A "DOVETAIL" JOINT [NEKOTORYYE REZUL'TATY EKSPERIMENTAL'NOGO ISSLEDOVANIYA SOYEDINENIYA TIPA "LASTOCHKIN KHVOST"]

Y. B. Gorlov *In its* News of Inst. of Higher Learning. Aeron. Eng. 10 Apr. 1967 p 141–144 refs (See N68-18668 09-23)

The maximum stresses in the holding sections of the wheel for dovetail connections were studied by photoelastic methods on an optical apparatus PPU-4. The results are shown in dimensionless form where the minimum values of the maximum stresses are represented. Author

N68-18687# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

NONSTATIONARY TEMPERATURE FIELD IN SANDWICH PLATES [NESTATSIONARNOYE TEMPERATURNOYE POLE V TREKHSLOYNYKH PLASTINAKH]

M. A. Il'Gamov *In its* News of Inst. of Higher Learning. Aeron. Eng. 10 Apr. 1967 p 153–160 refs (See N68-18668 09-23)

The temperature distribution in a three-layer plate was studied analytically for arbitrary layer parameters as asymmetric heating. The edges of the plate are thermally insulated, and at time $t=0$ the top and bottom parts have constant temperatures. Using the Laplace transformation, a set of three equations is obtained describing the temperature distribution in the three layers. To simplify calculations, a set of positive parameters is defined. These parameters characterize the geometric as well as the physical parameters of the problem. To illustrate the analysis, a numerical example is given, and a time vs. temperature plot is obtained throughout the plate. Author

N68-18690# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

INFLUENCE OF THE MAGNITUDE OF BOLT TIGHTENING ON THE STRENGTH OF BOLT JOINTS [VLIYANIYE VELICHINY ZATYAZHKI BOLTOV NA PROCHNOST' BOLTOVYKH SOYEDINENIY]

A. I. Yarkovets *In its* News of Inst. of Higher Learning. Aeron. Eng. 10 Apr. 1967 p 173–180 refs (See N68-18668 09-23)

The effects of bolt tightening on the strength of bolted connections under shear loads were investigated. The fatigue life of joints in shear was measured as a function of tightening torque by periodic loading to 0.7 of the static yield load. Three steel sheet joints joined with 8×10^{-3} m bolts were tested in shear to determine the stress corresponding to the relative proportional limit. Author

N68-18721*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

AN EXPERIMENTAL STUDY OF THE INFLUENCE OF THE TURBULENT BOUNDARY LAYER ON PANEL FLUTTER

Lado Muhlstein, Jr., Peter A. Gaspers, Jr., and Dennis W. Riddle Washington Mar. 1968 55 p refs

(NASA-TN-D-4486) CFSTI: HC $3.00/MF $0.65 CSCL 20K

Flutter dynamic pressure and flutter frequency were obtained for a rectangular unstressed isotropic panel with all edges clamped for the following sets of parameters: (a) Panel length-to-width ratio of 0.5, Mach number range of 1.05 to 1.40, and ratio of boundary-layer thickness to panel length of 0.032 to 0.111; (b) panel length-to-width ratio of 2.0, Mach number of 1.20, and ratio of boundary-layer thickness to panel length of 0.016 to 0.056. For the configurations tested, it is shown that the turbulent boundary layer has a large stabilizing influence on the flutter of flat panels. The effect on flutter dynamic pressure is maximum near $M=1.20$ and decreases rapidly with increasing Mach number. The effect on flutter frequency is minimum near $M=1.20$ and increases with increasing Mach number. Author

N68-18754# United Kingdom Atomic Energy Authority, Risley (England). Reactor Group.

AN INVESTIGATION INTO THE STRUCTURAL BEHAVIOUR AND SAFETY OF A SPHERICAL PRESTRESSED CONCRETE PRESSURE VESSEL. PART 1: MAIN TEXT

A. L. L. Baker (Imperial Coll. of Sci. and Tech.), M. L. A. Moncrieff (Imperial Coll. of Sci. and Tech.), I. Davidson, T. C. Waters, and N. T. Barrett 1967 69 p Reprinted

(TRG-1204(R), Pt. 1) HMSO: 11s

Design, construction, instrumentation and testing of a 1:11.5 scale model of a reactor pressure vessel, are described along with the associated control tests. The prototype vessel was a six-panel ribbed sphere, and the test program was designed to investigate the structural behavior of the vessel under both short- and long-term pressure and temperature loading. Predictions of elastic behavior by the 'dynamic relaxation' method agreed well with measured results for short-term temperature and pressure loading. Difficulties were encountered when trying to predict the long-term behavior of the vessel, and a comparison with measured results could only be obtained by using an 'equivalent hollow sphere' concept. The vessel was subjected to the design pressure and a temperature cross-fall that was more than four times the design value. The cracks that appeared were not of excessive width and closed when the load was removed. Author

N68-18755# United Kingdom Atomic Energy Authority, Risley (England). Reactor Group.

AN INVESTIGATION INTO THE STRUCTURAL BEHAVIOUR AND SAFETY OF A SPHERICAL PRESTRESSED CONCRETE PRESSURE VESSEL. PART 2: APPENDIX A

A. L. L. Baker (Imperial Coll. of Sci. and Tech.), M. L. A. Moncrieff (Imperial Coll. of Sci. and Tech.), I. Davidson, T. C. Waters, and N. T. Barrett 1967 176 p Reprinted

(TRG-1204(R), Pt. 2) HMSO: 8s

Tables and graphs detail the testing results for the structural behavior and safety of a spherical prestressed concrete pressure vessel. Dial gauges, Demec gauges, electrical resistance strain gauges, and thermocouples provided results of various pressure tests; and surface rosette strain readings are included. In addition to the instrumentation, age at the start of the test and a description of each test are presented. M.W.R.

N68-18756# United Kingdom Atomic Energy Authority, Risley (England).

AN INVESTIGATION INTO THE STRUCTURAL BEHAVIOUR AND SAFETY OF A SPHERICAL PRESTRESSED CONCRETE PRESSURE VESSEL. PART 3: APPENDICES B, C AND D

A. L. L. Baker (Imp. Coll. of Sci. and Technol.), M. L. A. Moncrieff (Imp. Coll. of Sci and Technol.), I. Davidson, T. C. Waters, and N. T. Barrett 1967 56 p refs
(TRG-1204(R), Pt. 3) HMSO: 7s

Instrumentation, construction and tensioning, and methods of testing are detailed for an investigation aimed at determining the structural behavior and safety of a spherical prestressed concrete pressure vessel. Concrete surface strains were measured by a mechanical gauge, called a Demec, and by electrical resistance strain gauges; bonded reinforcement strains were measured by the latter type; and radial deflections were measured by dial gauges. Five load cells were cast into the concrete in an unsuccessful attempt to measure stresses, and Chromel-Aluminel thermocouples were cast into the concrete to measure temperature distributions. Prestressing was accomplished by photoelastic cells placed at the anchorages at one end of each of the six cables. Pressure testing up to 400 lb/in.^{2} and ultimate test load at pressures above this are described, as is the method of temperature testing. M.W.R.

N68-18757# United Kingdom Atomic Energy Authority, Risley (England)
AN INVESTIGATION INTO THE STRUCTURAL BEHAVIOUR AND SAFETY OF A SPHERICAL PRESTRESSED CONCRETE PRESSURE VESSEL. PART 4: APPENDIX E
A. L. L. Baker (Imp. Coll. of Sci. and Technol.), M. L. A. Moncrieff (Imp. Coll. of Sci. and Technol.), I. Davidson, T. C. Waters, and N. T. Barrett 1967 56 p refs
(TRG-1204(R), Pt. 4) HMSO: 7s

Long term temperature-test supporting information is presented for a computer program designed to determine the structural behavior and safety of prestressed concrete pressure vessels. The method of averaging model results is described, and mathematical techniques for predicting equivalent hollow sphere behavior are presented. The computer program itself is included, as are typical input and output data for the model history simulation. E.J.S.

N68-18758# United Kingdom Atomic Energy Authority, Risley (England).
AN INVESTIGATION INTO THE STRUCTURAL BEHAVIOUR AND SAFETY OF A SPHERICAL PRESTRESSED CONCRETE PRESSURE VESSEL. PART 5: APPENDIX F
A. L. L. Baker (Imp. Coll. of Sci. and Technol.), M. L. A. Moncrieff (Imp. Coll. of Sci. and Technol.), I. Davidson, T. C. Waters, and N. T. Barrett 1968 51 p refs Reprint
(TRG-1204(R), Pt. 5) HMSO: 8s

Data are presented on concrete mix design, testing, construction materials of the prestressing cables for use in a scale 1:11.5 scale model spherical prestressed concrete reactor pressure vessel. Details are given for control tests and fundamental properties tests on plain concrete specimens. These included tests of compressive, tensile, and biaxial strength; elastic properties; creep and shrinkage; and determination of coefficient of expansion. Concrete specimens used were shaped as beams, cubes, cylinder, disks, prisms, and slabs; and compositions of the various mixes are given. Graphs depict the testing results. M.W.R.

N68-18759# United Kingdom Atomic Energy Authority, Risley (England). Reactor Group.
AN INVESTIGATION INTO THE STRUCTURAL BEHAVIOUR AND SAFETY OF A SPHERICAL PRESTRESSED CONCRETE PRESSURE VESSEL. SUPPLEMENT 1: ULTIMATE TEST
A. L. L. Baker (Imperial Coll. of Sci. and Tech.), M. L. A. Moncrieff (Imperial Coll. of Sci. and Tech.), I. Davidson, T. C. Waters, and N. T. Barrett 1967 21 p Reprinted
(TRG-1204(R), Sup. 1) HMSO: 7s

Results are given for the ultimate test performed on a 1:11.5 scale model of a spherical prestressed concrete pressure vessel. The vessel yielded at a pressure of 630 lb/in^2 inside the vessel; cracks in panels B and D were 5/32 and 1/4 in. wide respectively at their maximum widths. Author

N68-18769*# General Dynamics Corp., San Diego, Calif.
DYNAMIC STABILITY OF SPACE VEHICLES. VOLUME 7: THE DYNAMICS OF LIQUIDS IN FIXED AND MOVING CONTAINERS
L. L. Fontenot Washington NASA Mar. 1968 149 p refs
(Contract NAS8-11486)
(NASA-CR-941; GDC-BTD67-056) CFSTI: HC $3.00/MF $0.65
CSCL 22C

This analytic review on stability and control of liquid-rocket powered missiles and space vehicles discusses theoretical hydrodynamics necessary to describe the motion of a heavy liquid enclosed in a rigid vessel which is itself in motion. An energy formulation for the system is written for six degrees of freedom and the concept is then extended to the case of the planar motion of a liquid propellant vehicle having a single tank and engine. Planar equations of motion are used to obtain the perturbation equations and to identify the role of the liquid motions. By replacing the liquid in the propellant tank with a simple mechanical system, the planar perturbation equations for the whole vehicle are obtained. Comparison of liquid motions and mechanical system motions show that the mechanical systems can duplicate the action of the liquid. G.G.

N68-18825*# General Dynamics Corp., San Diego, Calif.
DYNAMIC STABILITY OF SPACE VEHICLES. VOLUME 10: EXIT STABILITY
R. F. Ringland Washington NASA Mar. 1968 166 p refs
(Contract NAS8-11486)
(NASA-CR-944; GD/C-BTD-67-029) CFSTI: HC $3.00/MF $0.65
CSCL 22A

Described are techniques in use for the stability analysis of launch vehicles during their flight through, and upon exit from, the earth's atmosphere. Indicated are analytical tools and techniques used in the analysis and synthesis of launch vehicle flight control systems during the actively propelled and controlled flight phases. The object of this presentation is to illustrate the applicability of standard computational techniques to the solution of complex flight control problems associated with large launch vehicles. Current space boosters are characterized, from the flight dominated by parasitic modes of response (elastic vehicle bending and, if liquid propelled, propellant sloshing). Reliance is placed on active flight control by means of thrust vector deflection for stability; fins are used, if at all, as passive elements to decrease the degree of instability in those instances where it proves impractical to adequately stabilize the vehicle with the control system gains allowable by consideration of system parasitics. Also fins may be indicated where abort systems require a reduced rate of attitude divergence in the event of a flight control system failure. Large in the above context refers to vehicles whose dynamic parameters vary slowly over a wide range. The rates of change of these parameters are far less than those of the dependent variables associated with the short-period modes of response. The analytical techniques presented are limited to systems that are, or can be approximated by, continuous systems; sampled data systems, digital autopilots, and the like are not considered. There is no coverage of the long-period modes due to guidance system action and guidance commands; rather, the guidance system is treated in a fashion similar to atmospheric disturbances: as a source of system excitation. Author

N68-19040 Texas Univ., Austin.
PARAMETRIC OSCILLATIONS OF A LONGITUDINALLY EXCITED CYLINDRICAL SHELL CONTAINING LIQUID
Daniel David Kana (Ph.D. Thesis) 1967 140 p
Available from Univ. Microfilms: HC $6.60/MF $3.00 Order No. 67-8117

Parametric oscillations of a liquid filled, circular cylindrical shell experiencing forced longitudinal excitation are investigated analytically and compared with experimental observations for several principal parametric modes. It is found that the linear axisymmetric forced response of the liquid-shell system forms an initial state in which the axisymmetric pressure forms a parametric loading on the shell, with respect to nonaxisymmetric coupled modes of the system. A perturbation technique is used to form the equations governing the perturbed, or variational state. A linear analysis of the perturbed state leads to a Mathieu equation which predicts the dynamic stability of the system. A nonlinear form of the shell displacements in the perturbed state leads to coupled nonlinear equations which are solved by methods of approximate analysis, in order to predict the amplitude response of the nonlinear motion during the parametric resonance. Dissert. Abstr.

N68-19114 Virginia Polytechnic Inst., Blacksburg.
DYNAMIC RESPONSE OF RECTANGULAR, ISOTROPIC AND ORTHOTROPIC PLATES UNDER VARIOUS CONSTRAINING CONDITIONS
Jen Yung Liu (Ph.D. Thesis) 1967 161 p
Available from Univ. Microfilms: HC $7.60/MF $3.00 Order No. 67-7387

The vibrations of rectangular, isotropic and orthotropic plates under various constraining conditions were studied. The kinds of constraint considered were: a cutout in the interior of the plate; a clamped area in the interior of the plate; and a cutout reinforced along the edges of the hole. First, the deflection function for a rectangular plate was represented by a double infinite series. Next, the finite difference method was applied. A third method based on the finite element procedure was based on: (1) the replacement of the continuous structure by an assemblage of component elements, and (2) the summing of the stiffness matrices and the consistent mass matrices of the elements. A fourth method known as the reflection method was also used. In this method, isotropic plate problems were approached by first considering the plate to be a portion of an infinite plate. Applications of these methods to the problem of determining the natural frequencies and their corresponding mode shapes for isotropic plates under the various constraining conditions were illustrated. In each case the necessary equations were developed and illustrative problems presented. Dissert. Abstr.

N68-19120 IIT Research Inst., Chicago, Ill.
NONLINEAR ELASTIC BUCKLING OF IMPERFECT ORTHOTROPIC CYLINDERS
Jeng-chong Shang (Ph.D. Thesis) 1967 53 p
Available from Univ. Microfilms: HC $3.00/MF $3.00 Order No. 67-6964

The main purpose of this study is to determine the elastic buckling strength of orthotropic cylinders based on the large deflection theory including the effect of initial imperfection. In order to check the theory developed, application was made to the case of ring-stiffened cylinders subjected to axial compression. In the first part, the basic equations are recapitulated. These equations include those for the displacement-strain relationship, stress–strain relationship, Airy's stress function, compatibility, and potential energy. In the second part, the energy method is employed to determine the buckling strength of orthotropic cylinders under axial compression. In the third part, the method developed is applied to the buckling of ring-stiffened cylinders under axial compression. Other factors studied include: (a) the effect of Poisson's ratio, (b) the effect of torsional rigidity and (c) the effect of stiffener spacing. Dissert. Abstr.

N68-19126*# Kaman Aircraft Corp., Bloomfield, Conn.
ANALYTICAL AND EXPERIMENTAL STUDIES ON GYROSCOPIC VIBRATION ABSORBERS (PART 1), AND ANALYSIS OF PARALLEL DAMPED DYNAMIC VIBRATION ABSORBERS (PART 2) Final Report
A. V. Srinivasan [1967] 89 p ref
(Contract NASw-1394)
(NASA-CR-93547) CFSTI: HC $3.00/MF $0.65 CSCL 20K

Three different gyroscopic configurations and a system of parallel damped dynamic vibration absorbers are analyzed. The gyroscope analysis provides for two degrees of translational freedom and three degrees of rotational freedom. Computer programs were written for calculating (1) null and natural frequencies; (2) responses in the direction of excitation and orthogonal to it; and (3) responses of the gyro. Details of electronic circuitry required to synchronize the gyro speed with the excitation frequency are presented. The parallel system is essentially a modification of the conventional damped vibration absorber, with a subsidiary undamped absorber mass added in parallel to the damped absorber mass. Numerical results are presented for the special case when the absorbed masses have the same magnitude. Two cases of tuning are considered. The possibility of obtaining antiresonance with the gyro in two orthogonal directions simultaneously and the advantages of the parallel damped absorber over conventional vibration absorbers were demonstrated. K.W.

N68-19143*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
FLUTTER OF CORRUGATION STIFFENED PANELS AT MACH 3 AND COMPARISON WITH THEORY
Herman L. Bohon Washington Mar. 1968 29 p refs
(NASA-TN-D-4321) CFSTI: HC $3.00/MF $0.65 CSCL 20K

Details of an experimental study on flutter of corrugation-stiffened panels are presented. The panels were tested at Mach 3 in the Langley 9- by 6-foot thermal structures tunnel under aerodynamic heating conditions. Flutter boundaries presented include a flat-panel portion and a thermally buckled panel portion. Comparison of the results from this investigation and other available data on corrugation-stiffened panels with conventional theory for panels simply supported on all edges indicates that theory is highly unconservative. However, accounting in the theory for the deflectional flexibility of the corrugations and supports at the ends of the corrugations brings theory and experiment into fair agreement. These results indicate that seemingly small details of edge conditions of corrugation-stiffened panels may cause drastic reductions in the dynamic pressure for flutter. Author

N68-19179 Stanford Univ., Calif.
MEMBRANE AND BENDING THEORY OF SINGLE AND MULTISPAN HYPERBOLIC PARABOLOID SHELLS
Eric Ivan Field (Ph.D. Thesis) 1967 116 p
Available from Univ. Microfilms: HC $5.80/MF $3.00 Order No. 67-7913

The membrane theory analysis of hyperbolic paraboloid shells is inadequate in that it predicts stresses which would require strain discontinuities. An analysis is needed which insures continuity of displacement. The membrane theory is reviewed and applied to single and multispan shells which use a funicular arch as a support condition at the shell intersections. The bending theory equations for shallow shells are solved by the method used for Lévy's solution of the plate bending problem. The corresponding bending equations for shallow parabolic arches are derived to provide an elastic support condition to be used in the bending theory analysis of multispan shells. Numerical solutions are obtained for single and multispan shells and are compared with the corresponding membrane solutions. Dissert. Abstr.

N68-19224# Stanford Univ., Calif. Dept. of Materials Science.
RESPONSE OF CIRCULAR CLAMPED PLATES TO SQUARE WAVE STRESS PULSES
T. R. Wilshaw and James M. Kelly. Aug. 1967. 48 p. refs.
Supported in part by ARPA
(Contract DA-31-124-ARO(D)-251)
(SU-DM5-67-36; AROD-4800.9-MC; AD-658401)

An account is given of an experimental investigation of the response of clamped circular mild steel plates of various thicknesses subjected to rectangular stress pulses over a small circular region. The stress pulses werd transmitted to the plates through a 1/2-inch diameter shock bar and the strain-time responses of the plates were measured. The stress wave interactions between the bar and the plates were measured for a number of thicknesses and the effect of the applied stress on the extent of the plastic deformation was determined. It was found that the elastic response was accurately predicted by the theory of Sneddon and the plastic response behaved according to a simple modification of this theory. The interaction between the stress pulse and plates of various thickness was theoretically predicted and found to be in excellent agreement with experimental measurements. The final plate deflections were theoretically predicted using a rigid viscoplastic theory and were in substantial agreement with the data. From this theory the data were analyzed to determine the viscoplastic constant or relaxation time of the material. Author (TAB)

N68-19228# Advisory Group for Aerospace Research and Development, Paris (France).
THE POTENTIALS OF COMPOSITE STRUCTURES IN THE DESIGN OF AIRCRAFT
1967. 74 p. refs. Presented at the 22d AGARD Struct. and Mater. Panel Meeting, Delft, Holland, 18–22 Apr. 1966
(AGARD-10) CFSTI: HC $3.00/MF $0.65

Recent developments and information are presented on structural design aspects of filamentary composites, particularly from a minimum weight standpoint. Included are a survey of analytical methods for filamentary composites, a review of the relative efficiency of various composites in terms of improved strength/density and stiffness/density ratios producing substantial weight savings, especially of aircraft wings, and some practical aspects of the present and future use of composite materials in aerospace application. Author

N68-19311*# Syracuse Univ. Research Inst., N. Y.
PLANE STRESS ANALYSIS OF AN EDGE-STIFFENED RECTANGULAR PLATE, TAKING INTO ACCOUNT BENDING AND SHEAR STIFFNESS OF THE STIFFENERS
Yu-wen Hsu and Charles Libove. Washington NASA. Mar. 1968. 178 p. refs.
(Grant NsG-385)
(NASA-CR-978; ME-1065-67B) CFSTI: HC $3.00/MF $0.65
CSCL 20K

A plane stress analysis, by means of Fourier series, is presented for an isotropic or orthotropic elastic rectangular plate bounded by four uniform edge stiffeners and subjected to any prescribed temperature distribution and boundary loads. Both the extensional and flexural (including transverse shear) stiffnesses of the stiffeners are considered, and the possibility is included that the plate is attached to the stiffeners along lines which are offset from their centroidal axes. At each corner the junction between the two meeting stiffeners is assumed to consist of a hinge and a coil spring. By varying the stiffness of the coil spring, any degree of joint rigidity, from that of a pure hinge to a perfectly rigid joint, can be simulated. Using this analysis, numerical results were obtained for a number of specific cases involving prescribed force loading or prescribed temperature distributions. As a check on the validity of the method, stresses were measured on a doubly symmetric edge stiffened square plate subjected to stiffener-end loads. Good agreement was obtained between the measured and computed values of the plate and stiffener stresses. Author

N68-19352# California Inst. of Tech., Pasadena.
SURFACE DEFORMATIONS IN A DRAINING CYLINDRICAL TANK. STABILITY OF A LAMINAR FILM ON AN INCLINED PLANE
Franklin Lester Marshall (Ph.D. Thesis). 1967. 92 p.
Available from Univ. Microfilms: HC $4.80/MF $3.00 Order No. 67-6979

The problem of draining of a liquid from a cylindrical tank through a hole in the bottom is considered. The flow is irrotational, and the free surface boundary conditions are linearized. Solutions are obtained and the shape of the free surface determined for any constant mass flow rate. At large mass flow rates, the free surface deforms appreciably when the mean depth is about 40 per cent or less of the tank diameter. The stability characteristics of a laminar film with a free surface flowing under the action of gravity down an inclined plane are examined. Approximate solutions of the Orr–Sommerfield equation are obtained. These are valid as long as the wave speed of the disturbance is somewhat larger than the maximum velocity of the undisturbed flow. Curves of neutral stability as functions of Reynolds number of the undisturbed flow and wave number of the disturbance are found. These are valid over a larger domain of Reynolds number and wave number than the previous results of Benjamin. Dissert. Abstr.

N68-19409# Cambridge Univ. (England). Cavendish Lab.
REPEATED LIQUID IMPACT AS A FATIGUE PROCESS
G. P. Thomas. *In* RAE. Rain Erosion and Assoc. Phenomena. Aug. 1967. p. 158–165. refs. (See N68-19401 09-13)

Metallographic analyses of materials eroded by repeated liquid impact found fractures emanating from erosion pits of largely transgranular character. Quantitative measurements of erosion and fatigue data on annealed steel, and precipitation hardened aluminum alloys subjected to water jet impact velocities of 145 m/sec to 60 m/sec established fatigue as the important corrosion factor for metals. Alloys of comparable strength behaved quite differently as the impact stress was reduced. Steel showed a disproportional resistance at velocities approaching 60 m/sec, followed by a leveling off of the stress endurance curve. The duraluminum erosion curve remained roughly constant at these velocities. Strain energy considerations proved partially successful in predicting fatigue endurances. G.G.

N68-19417# Royal Aircraft Establishment, Farnborough (England).
COMPARATIVE RESEARCH ON MATERIALS DESTRUCTION DURING RAIN DROP AND DURING CAVITATION [VERGLEICHENDE UNTERSUCHUNGEN ZUR WERKSTOFFZERSTOERUNG BEIM TROPFENSCHLAG UND BEI DER KAVITATION]
H. Rieger. *In its* Rain Erosion and Assoc. Phenomena. Aug. 1967. p. 260–277. refs. In GERMAN. (See N68-19401 09-13)

Water drop impingement, and cavitation damage tests on metals, glasses, ceramics, and plastics were compared for erosion resistant properties. Results showed that both methods effect the tested materials through the repeated brief and localized shocks; drop impact shocks concentrated more at the impact point and did not spread as much as cavitation shocks. The damage mechanism of metals was similar in both test methods and probably also for the other materials tested. A quantitative correlation between cavitation and drop impact damage was not established. G.G.

N68-19418# Royal Aircraft Establishment, Farnborough (England).
EROSION BY SOLID PARTICLES [EROSION DURCH FESTKOERPER]
W. Kayser. *In its* Rain Erosion and Assoc. Phenomena. Aug. 1967. p. 278–290. refs. In GERMAN. (See N68-19401 09-13)

Sand erosion shock tests on metal, glass, steel, and polyurethane samples at velocities of 410 m/s are compared to

determine the erosion resistance of various aircraft structural materials. Theoretical and experimental analyses of micrometeorite impact shock and erosion curves established the linear correlation between erosion resistance and material density. Studied are window glass, plexiglas, iron, steel, aluminum, and polyurethane. Transl. by G.G.

N68-19419# Royal Aircraft Establishment, Farnborough (England).
EROSION BY LIQUID SHOCK
J. H. Brunton *In its* Rain Erosion and Assoc. Phenomena Aug. 1967 p 291–309 refs (See N68-19401 09-13)

The effects of liquid impact shocks on solids were studied by relating droplet erosion with cavitation erosion processes. High speed water jet impaction on polymethyl metacrylate, and on a ductile aluminum/copper alloy produced elastic deformations in areas of compression and fracture in regions of tension; materials failed under combined actions of tensile stress and stress waves from the high velocity impact. A reduction in deformation was obtained by the presence of a liquid film on the impacted surface. Increasing plate thicknesses and angle of attack variations showed that the spalling fracture diameter decreased at normal incedence to zero at an angle between 40° and 45°; the compression wave distribution was altered so that the greater particle velocity and stress propagated along the line of impact. G.G.

N68-19425# Royal Aircraft Establishment, Farnborough (England).
INFLUENCE OF TEST PARAMETERS ON RAIN EROSION [EINFLUSS DER VERSUCHSPARAMETER AUF DIE REGENEROSION]
G. Hoff and G. Langbein *In its* Rain Erosion and Assoc. Phenomena Aug. 1967 p 399–410 In GERMAN (See N68-19401 09-13)

This survey depicts experimental parameter effects on material erosion by liquid shock impingement. Determined are shock velocity, angle of attack, temperatures, rain density, droplet diameter, surface tension and gas content of water, and dynamic pressure and flow around moving bodies. Transl. by G.G.

N68-19426# Royal Aircraft Establishment, Farnborough (England).
RESISTANCE OF MATERIALS UNDER VARIOUS MECHANICAL STRESSES [FESTIGKEIT VON WERKSTOFFEN BEI VERSCHIEDENER MECHANISCHER BEANSPRUCHUNG]
G. Hoff and G. Langbein *In its* Rain Erosion and Assoc. Phenomena Aug. 1967 p 411–427 refs In GERMAN (See N68-19401 09-13)

Analyzed is the correlation between erosion resistance and water drop size for its relationship to material strength. Since an increased drop size produces smaller eroding particles, the production of a new surface increases with volume and thus makes it possible to obtain the surface energy and internal energy values of the eroding particles. Test results on glasses, ceramics, aluminum, iron, polymer carbonates, and polymethyl methacrylate are statistically evaluated to obtain the erosion dependence on water drop size. Also discussed are the luminous phenomena developing during water shock in connection with deformation velocities involved. Transl. by G.G.

N68-19427# Royal Aircraft Establishment, Farnborough (England).
SINGLE IMPACT STUDIES WITH LIQUIDS AND SOLIDS
A. A. Fyall *In its* Rain Erosion and Assoc. Phenomena Aug. 1967 p 428–442 refs (See N68-19401 09-13)

The techniques of high-speed photography, photomicrography and profilimetry are described as applied to the study of single impacts of droplets of various materials with a fast-moving surface. Analyses are presented of some of the results obtained, principally on the various stages of erosions by waterdrop impact. These include the effects of pressure build-up and radial velocity, and an interpretation of the damage sites and of their possible correlation with multiple impact erosion. Finally, impact with solid particles is discussed with particular reference to simulation techniques and the suitability of materials to such methods. Author

33 THERMODYNAMICS AND COMBUSTION

Includes ablation, cooling, heating, heat transfer, thermal balance, and other thermal effects; and combustion theory. For related information see also: 12 Fluid Mechanics; and 27 Propellants.

N68-18307# Lockheed Missiles and Space Co., Sunnyvale, Calif.
THERMAL RADIATION PHENOMENA. VOLUME 4: EXCITATION AND NON-EQUILIBRIUM PHENOMENA IN AIR Final Report
Rolf K. Landshoff and John L. Magee Nov. 1967 306 p refs
(Contract DA-49-146-XZ-198)
(LMSC-3-27-67-1, V. 4; DASA-1917-4; AD-664496)

The report deals with excitation and non-equilibrium phenomena in air that has been subjected to a large amount of radiation. The following topics are covered: Absorption and scattering of X-rays and gamma rays in air; Collisions of ions and electrons with air molecules; Secondary processes following this excitation. (This includes the creation of various chemical species); X-ray heating and shock heating of air with special reference to very high energy densities; The approach to composition equilibrium in low and high temperature air; Adiabatic, near equilibrium cooling of air and the formulation of a criterion for local thermodynamic equilibrium; Non-equilibrium radiative transport and its effect on the total amount and the spectrum of emitted radiation; Radiation in tenuous air at high temperatures; Radiation in tenuous air with contaminants at low temperatures. The report has two appendices. One discusses mathematical aspects of the approach to equilibrium of a displaced system. The other one presents a table of the states and spectra of the metallic monoxides. Author (TAB)

N68-18308# Ohio State Univ. Research Foundation, Columbus. Dept. of Mechanical Engineering.
EFFECTS OF A TRANSVERSE ELECTRIC FIELD ON THE CHARACTERISTICS AND HEAT TRANSFER OF A DIFFUSION FLAME
Edwin R. Pejack and Henry R. Velkoff Nov. 1967 142 p refs
(Contract DA-31-124-ARO(D)-246)
(TR-8; AROD-4942.8-E; AD-664180)

Effects of a transverse electric field on a parallel flow diffusion flame in a flat combustion chamber were investigated. Various mixtures of propane, nitrogen, and air were introduced separately at the base of an experimental combustion chamber and burned in a diffusion flame sheet located between flat walls of the chamber which served as anode and cathode. The electrode walls were instrumented to measure the local heat transfer rate, local current density, and pressure. It was found that the application of a voltage difference across the electrodes moved ions out of the burning zone and resulted in a current at the electrode walls. The heat transfer rate near the base of the flame was considerably increased on the cathode and decreased on the anode; at positions further from the base of the flame the electric effect was lessened. Flame distortion was thought to be caused by electrically induced gas motion derived from a gradient in current density in the flow direction and by the onset of an electrically induced flame flickering. An analysis of the products of combustion revealed that the applied electric field acted to increase the amount of unburnt solid carbon and decrease the quantities of unburnt fuel and carbon monoxide. Author (TAB)

N68-18341# California Univ., Berkeley. College of Engineering.
MASS SPECTROSCOPIC OBSERVATION OF IGNITION PHENOMENA IN A SMALL ROCKET COMBUSTION CHAMBER
Robert F. Sawyer [1967] 18 p refs
(Grant AF-AFOSR-1256-67)
(WSCI-67-39; AFOSR-68-0225; AD-664580)

Observations of small rocket firings were examined for evidence of ignition phenomena. Qualitative analysis of product gas composition was made through molecular beam sampling from the combustor wall and direct mass spectrometer analysis. The combustion of hydrazine/nitrogen tetroxide and of hydrazine/chlorine pentafluoride were observed. The technique allows following the sequence of species present in the chamber during the ignition phase. Time resolution was limited by data recording techniques to 22 msec. Author (TAB)

N68-18366# Princeton Univ., N. J. Guggenheim Labs. for the Aerospace Propulsion Sciences.
RADIATION AUGMENTED BURNING OF A SOLID PROPELLANT Interim Scientific Report
T. J. Ohlemiller and M. Summerfield Nov. 1967 43 p refs
(Contract Nonr-1858(32))
(Rept.-799; AD-664252)

An experimental situation was devised in which the gaseous flame of a regressing solid propellant was suppressed and replaced by a radiative input to the sample surface so as to allow a detailed examination of the energetics of propellant gasification. The desired flameless regression condition was attained for at least two PBAA/AP compositions. However, two seriously detrimental effects entered into the experiments: an abnormally large proportion of AP was ejected from the regressing sample surface and the unejected fraction largely sublimed without further reaction. The combination of these two factors and the very low pressures required in the tests severly limits the applicability of the results to normal propellant combustion. Author (TAB)

N68-18403# Royal Aircraft Establishment, Farnborough (England).
EQUILIBRIUM TEMPERATURES ON LIFTING SURFACES AT MACH NUMBERS BETWEEN 5 AND 12 AT ALTITUDES FROM 80,000 FT UP TO 150,000 FT
A. Naysmith and J. G. Woodley May 1967 46 p refs
(RAE-TR-67114; AD-664527)

Computations were made of equilibrium skin temperatures on a wedge surface for a range of free stream Mach numbers of 5 to 12, for both fully laminar and fully turbulent boundary layers. The range of surface pressure coefficient from 0 to 0.1 (which fixes the wedge angles) and altitudes from 80,000 to 160,000 ft were covered. The possibility of using the results for other slender bodies is discussed, and in addition some results are included, by way of illustration, in order to show the amount of heat which would have to be absorbed through a surface in a particular case in order to maintain it at a fixed skin temperature. Author (TAB)

N68-18427# Princeton Univ., N. J. Dept. of Aerospace and Mechanical Sciences.
A STUDY OF THE MECHANISMS OF HEAT TRANSFER IN OSCILLATING FLOW
David W. Bogdanoff Oct. 1967 339 p refs
(Contract Nonr-1858(29))
(TR-483-f; AD-664248)

Measurements were made in a turbulent, unsteady environment provided within a duct which was placed in longitudinal mode resonance by a siren arrangement. Importance of the velocity antinode locations and the degree of flow reversal in the enhancement of heat transfer was indicated. Measurement techniques utilized a steam-heated axially-segmented test section which covered more than one wave length of the imposed oscillations; and constant-temperature hot-wire probe surveys of the core and boundary layer in both the steady-state and unsteady duct environments. Measurements were compared with other applicable research. The important parameters were outlined together with a quasi-steady analysis. The mechanism which best correlated the experimental measurements and analyses was the effect of the oscillations on the turbulence exchange properties, while viscous dissipation and acoustic streaming appeared to be unimportant for many cases of interest. Total (eddy plus molecular) viscosity plots indicated regions of generation of abnormal turbulence and subsequent diffusion and decay. Author (TAB)

N68-18439# RAND Corp., Santa Monica, Calif.
COMPUTATION OF THE RESOLVENT FOR THE AUXILIARY EQUATION OF RADIATIVE TRANSFER
J. Buell, H. Kagiwada, R. Kalaba, A. McNabb, and A. Schumitzky Jan. 1968 28 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5520-PR; AD-664322)

The solution of the auxiliary equation of radiative transfer is written in terms of the resolvent, and an initial-value method for the resolvent is presented. This forms the basis for an effective numerical treatment exploiting the ability of modern computers to integrate a large number of simultaneous ordinary differential equations. Some computational results are given, along with evidence for their validity. Author (TAB)

N68-18442# Princeton Univ., N. J. Guggenheim Labs. for the Aerospace Propulsion Sciences.
HEAT TRANSFER IN OSCILLATING FLOW Final Report, 1958–1967
David T. Harrje 15 Oct. 1967 10 p refs
(Contract Nonr-1858(29))
(Rept.-483-g; AD-664303)

A brief summary is provided of an extensive research into heat transfer with oscillating flow. Significant heat transfer increases were demonstrated without combustion. Measurements were made in a turbulent, unsteady environment provided within a duct which was placed in longitudinal mode resonance by a siren arrangement. Importance of the velocity antinode locations and the degree of flow reversal in the enhancement of heat transfer was indicated. Measurement techniques utilized a heated strip, axially traversing the tube between node and antinode locations; a steam-heated axially-segmented test section which covered more than one wave length of the imposed oscillations; and constant-temperature hot-wire probe surveys of the core and boundary layer in both the steady-state and unsteady duct environments. The mechanism which best correlated the experimental measurements and analyses was the effect of the oscillations on the turbulence exchange properties, while viscous dissipation and acoustic streaming appeared to be unimportant for many cases of interest. Author (TAB)

N68-18447# Aerospace Corp., El Segundo, Calif. Lab. Operations.
RADIATIVE TRANSPORT IN AN OPTICALLY THICK PLANAR MEDIUM, OCTOBER–DECEMBER 1967
George Emanuel Dec. 1967 16 p refs
(Contract F04695-67-C-0158)
(TR-0158(3240-20)-7; SAMSO-TR-68-16; AD-664556)

The problem of radiative transport of thermal energy between parallel, black, diffusely-emitting walls is solved by the method of matched asymptotic expansions when the intervening grey gas is optically thick. There is a thin thermal layer adjacent to each wall in which the Rosseland diffusion approximation is invalid. It is shown that this layer is closely connected to the restricted Milne problem of astrophysics, and that the layer disappears if the Milne-Eddington (or any equivalent) approximation is made. A simple, uniformly valid solution for temperature, temperature slip at the walls, and heat flux is given for the optically thick limit. Author (TAB)

N68-18465# European Space Technology Center, Noordwijk (Netherlands).
AN INVESTIGATION OF THE VALIDITY OF BLACK BALL TESTS
L. A. Husain Paris ESRO Nov. 1967 15 p
(ESRO-TM-102(ESTEC)) CFSTI: HC $3.00/MF $0.65

A simple theoretical analysis is presented showing the effect of experimental uncertainties in the various parameters involved when using a black ball as a calibrating device in space chambers. Its use as a solar radiation fluxmeter and as a means of establishing a chamber correction factor is considered, and it is shown that great care must be exercised in the interpretation of results when the ball mean temperature is used as the experimentally measured variable. Author (ESRO)

N68-18478 Syracuse Univ., N. Y.
HEAT TRANSFER IN FLUIDIZED AND PACKED BEDS BY FREQUENCY RESPONSE METHODS
Ronald Gene Barile (Ph.D. Thesis) 1966 180 p
Available from Univ. Microfilm: HC $8.20/MF $3.00 Order No. 67-7126

The frequency response technique has been used to study gas-particle heat transfer in fluidized and packed beds. A model is presented which accounts for eddy dispersion of heat in the gas, solids mixing in a fluidized bed, and solid-phase conduction in a packed bed. Experiments with air as the fluid were conducted in beds of copper, glass, and lead spheres from 0.0064 to 0.08 inches in diameter, spanning the particle Reynolds number range of 0.29 to 99.2. The fluidized bed data were limited to flows within 15 percent of the minimum-fluidizing velocity. Since the data correspond to an asymptotic solution of the theoretical model, only minimum values of heat transfer and mixing coefficients are realized. This behavior verifies the frequent assumption that fluidized solids have a uniform temperature throughout the bed. The results for heat transfer coefficients indicate that existing correlations in the literature may be too low at Reynolds numbers near 1.0; whereas, mixing coefficients obtained in this study agree favorably with independent mixing experiments and with bubble theories. Dissert. Abstr.

N68-18488*# Avco Corp., Lowell, Mass. Space Systems Div.
EVALUATION OF THE THERMAL PROPERTIES OF MATERIALS, VOLUME 1: TECHNICAL REPORT Final Report, 29 Jun. 1965–28 Jun. 1966
30 Sep. 1966 107 p refs
(Contract NAS9-4874)
(NASA-CR-65979; AVSSD-0197-66-CR) CFSTI: HC $3.00/MF $0.65 CSCL 20M

This report presents the results of measurements of the thermophysical properties of materials used for manned spacecraft. The purpose of the experimental program was to provide the thermal properties of structural materials, ablators, insulations, seals, and adhesives for manned spacecraft. The environments considered were atmospheric pressure and vacuums to 10^{-5} torr, and some materials were evaluated both in the virgin and charred state. The temperature range of measurement was from −250 to 2000°F. The parameters evaluated were apparent thermal conductance, apparent thermal conductivity, enthalpy and specific heat, density, weight loss, reaction energies, heat of combustion, viscous and inertial resistance coefficient, optical reflectance, material transient response, anisotropy of various parameters, char temperature, and prechar procedures. Author

N68-18508# ARO, Inc., Arnold Air Force Station, Tenn.
EFFECT OF INTERNAL RADIATION ON THE TEMPERATURE DISTRIBUTION OF A SPHERICAL SHELL Final Report, Jun.–Dec. 1966
Donald C. Todd, Jan A. van der Bliek, and Han M. Hsia Arnold Eng. Develop. Center Jan. 1968 39 p refs
(Contract AF 40(600)-1200)
(AEDC-TR-67-254; AD-664081)

The report is a continuation of a study of the effects of internal heat transfer on the temperature of hollow spacecraft and the requirements for thermal modeling. Considered is the effect of internal heat transfer by radiation on the temperature distribution. The equation governing the heat transfer of a spherical shell exposed to parallel radiation is derived; conduction and radiation are considered. The general equation is simplified by assuming steady state, and a numerical method is given to solve the steady state equation. A computer program is described which employs the method. Solutions of the steady state equation are graphically presented and discussed. The requirements for temperature preservation in thermal modeling are derived. The possibility of thermal modeling without temperature preservation is discussed. It is observed that for an inside emissivity to outside emissivity ratio greater than one, the requirement for duplication of the other dimensionless ratio can be relaxed. Author (TAB)

N68-18597# California Univ., Berkeley.
STUDY OF THE DEVELOPMENT AND STABILIZATION OF DETONATIONS Final Report, Oct. 1966–Oct. 1967
A. K. Oppenheim Oct. 1967 8 p refs
(Grant AF-AFOSR-129-67)
(AFOSR-68-0129; AD-664001)

The subject matter of the report is the program of the study of gas-wave-dynamic phenomena during the transient state from combustion initiation to stable detonation. The results should provide basic information on the general of pressure waves by explosive reactions, important to understanding of combustion instability in rocket chambers and similar devices, as, for instance, supersonic combustion propulsion systems for hypersonic flight vehicles. Author (TAB)

N68-18630*# Massachusetts Inst. of Tech., Cambridge. Dept. of Mechanical Engineering.
BUBBLE FORMATION AND GROWTH. STUDY OF THE BOUNDARY CONDITIONS AT A LIQUID-VAPOR INTERFACE THROUGH IRREVERSIBLE THERMODYNAMICS Quarterly Progress Report, Sep.–Nov. 1967
Ravinder K. Sakhuja Jan. 1968 72 p refs
(Contract NAS8-20013)
(NASA-CR-61628) CFSTI: HC $3.00/MF $0.65 CSCL 20M

The purpose of this study is to investigate theoretically and experimentally the condensation coefficient and other transport coefficients appearing in linear irreversible thermodynamics rate equations of a phase change by performing a steady state evaporation of mercury. The steady state evaporation experiment has been performed for higher pressures (> 0.017 atm), and the average value of "σ" has been found to be 0.79. A kinetic theory model has been developed to study the condensation process and the behavior of condensation coefficient "σ" at higher values of pressure thereby showing that it is possible for the condensation coefficient to be less than unity. The average value of the other transport coefficient "K" has been found to be 0.36. Author

N68-18675# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INVESTIGATION OF THE INFLUENCE OF THE VIBRATIONS OF A BODY ON THE COEFFICIENT OF HEAT TRANSFER UNDER CONDITIONS OF FREE CONVECTION [ISSLEDOVANIYE VLIYANIYA VIBRATSIY TELA NA KOEFFITSIYENT TEPLOOTDACHI V USLOVIYAKH SVOBODNOY KONVEKTSII]
L. I. Kudryashev and Yu. A. Tkachev *In its* News of Inst. of Higher Learning. Aeron. Eng. 10 Apr. 1967 p 62–71 refs
(See N68-18668 09-23)

The effect of the vibrations of a body on the heat transfer coefficient in free convection was studied experimentally. Tests were made with a vibrating specimen in the frequency range from 50 to 200 cps and amplitudes of 0.1–1.2 mm, while the specimen was cooled from 200°C. In formulating a theoretical model of the problem, it was assumed that a quasi-steady motion of the medium was developed in the vicinity of the vibrations of the heated or cooled surface. The formulated theoretical model made possible the approximate integration of the system of differential equations which describes the problem. Author

N68-18679# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

TEMPERATURE STATE OF A POROUS PLATE WITH VOLUME HEAT RELEASE FOR EFFUSIONAL COOLING [TEMPERATURNOYE SOSTOYANIYE PORISTOY PLASTINY S OB"YEMNYM TEPLOVYDELENIYEM PRI EFFUZIONNOM OKHLAZHDENII]

V. K. Shchukin and A. F. Koval'nogov *In its* News of Inst. of Higher Learning. Aeron. Eng. 10 Apr. 1967 p 101–108 refs (See N68-18668 09-23)

The cooling of porous plates with internal heat release by passage of gas can be used in nuclear reactors with porous fuel elements or for heating gas by passage through electrically heated porous plates. The maximum temperature and the temperature profile are of importance for determining the thermal stress in the plate. A method, based on the assumption that the temperatures of the gas inside the pores and the pore walls are equal is used. To investigate the effect of this simplifying assumption, exact formulas were derived which allow for the temperature difference between the gas and the wall, and plots were obtained for the error caused by the simplifying assumption as a function of the heat transfer coefficient and thermal conductivity of the material. The results showed that a decrease in thermal conductivity increases the error; a change in the heat transfer coefficient has only a slight effect on the error. The maximum temperature can be calculated by the simplified method with sufficient accuracy only when the thermal conductivity is sufficiently high and the porosity comparatively low. Author

N68-18689# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ON THE QUESTION OF DETERMINING THE COMPONENTS OF CONTACT THERMAL RESISTANCE [K VOPROSU OB OPREDELENII SOSTAVLYAYUSHCHIKH KONTAKTNOGO TERMICHESKOGO SOPROTIVLENIYA]

P. Ye. Khizhnyak *In its* News of Inst. of Higher Learning. Aeron. Eng. 10 Apr. 1967 p 167–171 refs (See N68-18668 09-23)

A simplified method is outlined for measuring the contact thermal conductivity for component materials without using vacuum chambers. A set of four equations is derived relating the various conductivities of the contact surfaces. These results are checked experimentally for 30KhGSA steel surfaces and are compared to the calculated results. The agreement is satisfactory. The results also show that at low heat loads the decrease in the mean thickness of the inter-contact layer is very sharp, but for higher heat loads it flattens off to an almost constant value. Author

N68-18813*# National Aeronautics and Space Administration, Washington, D. C.

USE OF HIGH PURITY MATERIALS IN THERMOMETRY [ZUR VERWENDUNG DER REINSTSTOFFEN IN DER THERMOMETRIE]

M. Richter Mar. 1968 12 p refs Presented at the Intern. Symp. on Pure Mater. in Sci. and Technol., Dresden, 30 Nov.–2 Dec. 1961

(NASA-TT-F-11548) CFSTI: HC $3.00/MF $0.65 CSCL 20M

The International Temperature Scale (ITS) consists of a series of fixed points. It includes the following equilibrium temperatures: the solidification temperatures of gold and silver, the boiling points of sulfur (and recently, zinc), water and oxygen, as well as the triple point of water. Other materials are used in the preparation of interpolation instruments, such as platinum for resistance thermometers or thermocouples. The accuracy required in the reproduction of these fixed points calls for materials of nearly spectroscopic purity. The paper deals with the total influence of impurities on the equilibrium temperatures, discusses suitable methods of purification, and provides data from recent investigations in this special field of high-purity materials. Author

N68-18853*# Avco Corp., Lowell, Mass. Space Systems Div.

EVALUATION OF THE THERMAL PROPERTIES OF MATERIALS. VOLUME 2: DATA HANDBOOK Final Report, 29 Jun. 1965–28 Jun. 1966

28 Jun. 1966 229 p refs

(Contract NAS9-4874)

(NASA-CR-65980; AVSSD-0197-66-RR) CFSTI: HC $3.00/MF $0.65 CSCL 20M

This program was primarily directed toward the study of aluminum honeycomb panel structures and Avco Ablator 5026-39. Because of data variation between panels, core depth, foil size, cell size, adhesive bond, node bond, and fabrication processes, a final analysis of the aluminum honeycomb data had to be iterative: experimental statistics were economically prohibitive. In some instances, where it was expected that correlation analysis would not be influenced by the testing of a complete series over the entire test range, the study was concentrated on temperature ranges where a different mode of heat transfer was expected to occur. In addition to both tabular and graphic illustrations of the results, included are critical comments related to material peculiarities when subjected to the various test environments. Arrangement of the information is according to material groups i.e., structural material, ablators, adhesives and seals, and insulations. Author

N68-18871# Los Alamos Scientific Lab., N. Mex.

THE TWO-DIMENSIONAL HYDRODYNAMIC HOT SPOT, VOLUME 4

Charles L. Mader 22 Nov. 1967 31 p refs

(Contract W-7405-ENG-36)

(LA-3771) CFSTI: HC $3.00/MF $0.65

The failure of a nitromethane detonation resulting from a side rarefaction cooling the explosive inside its reaction zone was calculated using an Eulerian, reactive, numerical, hydrodynamic code. The velocity of the rarefaction agreed with the experimental measurements of Davis. The formation of hot spots from the interaction of a shock in nitromethane with a cylindrical or rectangular void, and the failure of the hot spot to initiate propagating detonation as a result of the rarefactions interacting with the reaction zone were computed. The interaction of the hot spots formed from several voids was computed. The basic two-dimensional processes involved in the shock initiation of heterogeneous explosives are numerically described. Future studies of the basic processes will require three-dimensional geometry. Author (NSA)

N68-18880# United Kingdom Atomic Energy Authority, Harwell (England). Research Group.

NATURAL CONVECTIVE BOILING OF THE ALKALI METALS—A CRITICAL REVIEW

J. G. Collier and P. G. Kosky Sep. 1967 77 p refs

(AERE-R-5436) HMSO: 11s

A knowledge of the characteristics of boiling liquid metals is of considerable importance in determining the performance of advanced nuclear power reactors. Considerable differences have been found to exist in the boiling heat transfer characteristics of sodium and potassium when compared to the behavior of a normal fluid such as water. For example the critical heat fluxes for sodium and potassium for pool boiling predicted by the hydrodynamic theories of Kutateladze and Zuber are nearly an order of magnitude lower than the experimental values at atmospheric and sub-atmospheric pressures. Consideration is given to the basic

aspects of boiling in relation to the alkali metals. Topics covered include nucleation theory in pool and forced convection systems, nucleation stability, bubble growth, and bubble detachment cycles. In addition the macroscopic aspects of natural convection, nucleation pool boiling, and film boiling are treated. Simple equations based on the thermo-physical properties of the alkali metals are recommended for the prediction of these overall properties. Author

N68-18929*# Princeton Univ., N. J. Dept. of Aerospace and Mechanical Sciences.

HETEROGENEOUS IGNITION OF METALS: MODEL AND EXPERIMENT Final Report, 1 May 1966–31 Oct. 1967

Arthur M. Mellor 1967 382 p refs

(Grant NsG-641)

(NASA-CR-93541, Rept.-816) CFSTI: HC $3.00/MF $0.65 CSCL 21B

Inefficient ignition and combustion of metallic additives in solid propellant rocket motors has stimulated interest in fundamental processes in the ignition of metals. A physical model of this heterogeneous process is presented, compared with other theories of ignition in view of literature studies of metal ignition, and finally tested by detailed experimentation in an induction furnace facility. Three temperatures form the basis of the model for any metal-oxidizing gas system. The first is a spontaneous ignition temperature, which is called the critical temperature, the second is the ignition temperature, at which immediate inflammation of the metallic fuel occurs, and the last is the transition temperature, which is invoked due to a problem unique to metal ignition. Author

N68-19016# Smithsonian Astrophysical Observatory, Cambridge, Mass.

EFFECTIVE THERMAL CONDUCTIVITY OF SNOW AT −88°C, −27°C, AND −5°C

D. Pitman and B. Zuckerman 31 Jan. 1968 28 p refs

(SAO Special Rept.-267)

The thermal conductivity of vapor-grown pseudodendritic snow crystals has been measured at −88°C, −27°C, and −5°C over a density range of 0.1 to 0.6 g cc^{-1} in a steady-state apparatus. Values are found to increase with increasing density and temperature. The measurements have allowed a more sensitive test to be made of a thermal conductivity model for porous media proposed by Woodside, and of an alternate model similar to one suggested by Wyllie and Southwick. The thermal conductivity equation that best represents the experimental data is a slightly modified version of the Woodside equation. Author

N68-19087# Brookhaven National Lab., Upton, N. Y.

EXPERIMENTAL STUDY OF HEAT TRANSFER FROM HORIZONTAL FLAT SURFACE TO SODIUM UNDER FREE CONVECTION

A. P. Kudryavtsev, D. M. Ovechkin, D. N. Sorokin, V. I. Subbotin, and A. A. Tsyganok [1967] 10 p refs Transl. into ENGLISH from the publ. "Zhidkie Metally" Moscow, Atomizdat, 1967 p. 131–136

(BNL-TR-167) CFSTI: HC $3.00/MF $0.65

Heat transfer experiments were conducted with a flat, horizontal stainless steel surface heated by electron bombardment. The level of sodium above the surface was 150 mm. The temperature field of the sodium was measured using a movable thermocouple. Sodium temperature profiles are given. Equations are given for calculation of heat transfer. NSA

N68-19175# Shell Research, Ltd., Chester (England). Thornton Research Center.

INVESTIGATION OF THE PECULARITIES OF PRE-FLAME PROCESSES AND IGNITION OF HYDROCARBONS OF VARIOUS STRUCTURES. PART 1: VARIATION OF COOL FLAME DELAY AND IGNITION DELAY WITH COMPRESSION TEMPERATURE AND PRESSURE

A. N. Voinov and D. I. Skorodelov [1967] 17 p refs Transl. into ENGLISH from Kinetika i Kataliz (USSR), v. 8, no. 2, 1967 p. 252–260 *Its* Transl. No. 1137

CFSTI: HC $3.00/MF $0.65

The effect of compression temperature and pressure on the ignition delay and cool flame delay of hydrocarbons of different structures (n-hexane, hexene-1, cyclohexane, cyclohexene, isooctane diisobutylene and a mixture of 60% isooctane with 40% n-heptane) in stoichiometric proportions with air, was investigated. Sharp differences in the nature of the preflame processes are demonstrated—as a function of the ignition delay—between saturated and unsaturated as well as between cyclic and acyclic hydrocarbons. Good agreement is shown between the variation of ignition delay with temperature for hydrocarbons of different structures and the peculiarities of their behaviour in engines, in particular the effect of temperature on the detonation tendency. Author

N68-19187*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

CONSIDERATIONS OF TURBINE COOLING SYSTEMS FOR MACH 3 FLIGHT

Francis S. Stepka Washington Apr. 1968 43 p refs

(NASA-TN-D-4491) CFSTI: HC $3.00/MF $0.65 CSCL 20M

A method is presented for rapidly determining the approximate average midspan metal temperatures and coolant flow requirements of turbine airfoils cooled by compressor exit bleed air. Presented also are the potential reductions in airfoil metal temperatures, coolant flows, or increases in average turbine inlet gas temperatures that are possible by utilization of various airfoil cooling designs, cooling methods, and cooling systems other than the direct use of compressor exit bleed air. These additional cooling systems were direct cooling with engine fuels (Jet A or liquid methane) and the use of heat exchangers to reduce the compressor exit bleed air temperature. The cooling fluids that were used in the heat exchangers were: engine fuel, by-pass air in the fan exit duct of a turbofan engine, and ram air. The analysis was conducted to engines of aircraft cruising at Mach 3 at an altitude of 75,000 feet (22.8 km). Turbine inlet gas temperatures from 2270° to 3170°F (1515° to 2020°K) were investigated. Author

N68-19195# Advisory Group for Aerospace Research and Development, Paris (France).

THERMO-MOLECULAR PRESSURE EFFECTS IN TUBES AND AT ORIFICES

Max Kinslow (ARO, Inc.) and George D. Arney, Jr. (ARO, Inc.) Aug. 1967 66 p refs

(Contract AF 40(600)-1200)

(AGARDograph-119) CFSTI: HC $3.00/MF $0.65

An investigation of the errors arising from thermal nonequilibrium in systems measuring gas pressures is presented. The errors are attributed to a phenomenon referred to as thermo-molecular pressure. This effect is investigated both theoretically and experimentally at sensing orifices and in tubes. A thorough review of the literature is given and a theory is developed for the error introduced in the limiting case of a very small sensing orifice with heat flux to the orifice surface. The theory takes into account the effect of arbitrary thermal accommodation coefficient at the orifice surface. Experimental data are presented separately for thermo-molecular pressures in tubes and at orifices. In addition, results of heat-transfer measurements in the transitional flow regime between flat plates are presented as a basis for correlating the orifice data. Finally, methods are given, with examples, for the correction of thermo-molecular effects both at orifices and in circular tubes. Author

N68-19201# Southampton Univ. (England). Dept. of Aeronautics and Astronautics.
THE STEADY EXPANSION OF SHOCK HEATED GASES FOR RECOMBINATION STUDIES
M. W. Slack, K. N. C. Bray, R. A. East, and N. H. Pratt [1967] 19 p refs Presented at 6th Intern. Shock Tube Symp., Freiburg, 12–14 Apr. 1967 Supported in part by Min. of Technol.
(AASU-272)

An analysis has been undertaken of the conditions for which Wilson's technique involving the steady Prandtl–Meyer expansion of shock heated gases is applicable. Experimental evidence for the existence of the predicted flow regimes is described, including measurements of static pressure, stagnation point heat transfer, infrared emission and optical absorption. Work involving iodine recombination is briefly mentioned. Author

N68-19241* Boeing Co., Seattle, Wash. Space Div.
APPLICATION OF MULTIVARIABLE SEARCH TECHNIQUES TO THE SHAPING OF MINIMUM TOTAL HEAT RE-ENTRY BODIES AT HYBERBOLIC VELOCITY
D. S. Hague [1968] 47 p refs
(Contract NAS2-4507)
(NASA-CR-73203) CSCL 20M

Based on results of previous studies, an analysis is presented on the total heat minimization for earth entry at hyperbolic speeds. The two objectives which were achieved, are construction of a minimum heating synthesis program coupled with the optimization program, and investigations of optimal shapes for bodies of revolution entering the earth's atmosphere at hyperbolic speeds using a tangent cone application. Closed form expressions for the component heat inputs to conical bodies are presented, and the results of heat fraction calculations performed over a range of entry velocities are shown. Tables are also given illustrating the optimal cone angles and heat fractions plotted as a function of entry velocity for three base radii. The body shaping studies based on heating conditions are discussed in relation to a cone which has the same half-angle and base radius as the truncated conical element. Equations for equilibrium radiation input, non-equilibrium radiation input, and convection heat input are derived and applied to a conical body to obtain the assumed heat input distributions on such a shape. B.S.D.

N68-19254 IIT Research Inst., Chicago, Ill.
MEASUREMENT OF ENTHALPY DIFFERENCES WITH A FLOW CALORIMETER
Joseph Patrick Dolan (Ph.D. Thesis) 1967 119 p
Available from Univ. Microfilms: HC $5.80/MF $3.00 Order No. 67-6965

A calorimeter facility has been constructed capable of defining the enthalpy fields of gases and liquids in the range between +200° F and −320° F for pressure below 2000 psia. This calorimeter facility is unique in that it can be used to define the entire enthalpy field over its operating range without recourse to enthalpy, Joule–Thomson, or specific heat data of others. In addition, the equipment can be operated to provide internal cross checks on the consistency of the enthalpy field. To achieve these capabilities, provision was made for the measurement of integral isobaric and isothermal enthalpy differences. Enthalpy differences measured by this apparatus have an uncertainty on the order of one percent. The calorimeter is described in detail with particular emphasis on the provisions for minimizing heat leaks and the statistical analysis necessary to establish the uncertainty of the measured enthalpy differences. Dissert. Abstr.

N68-19314*# National Bureau of Standards, Boulder, Colo. Cryogenics Div.
COOLDOWN TIME FOR SIMPLE CRYOGENIC PIPELINES
W. G. Steward, R. V. Smith, and J. A. Brennan 23 Aug. 1967 20 p refs Presented at the 10th Midwestern Mech. Conf., Ft Collins, Colo., 21–23 Aug. 1967
(NASA Order R-45)
(NASA-CR-91256) CFSTI: HC $3.00/MF $0.65 CSCL 20M

An uncooled pipeline which is used to transfer a cryogenic fluid from one point to another must ordinarily go through a period of cooling down from ambient temperature to near the liquid boiling temperature. During most of the cooldown period the liquid boils and the pipe delivers only warm gas. This paper offers a quick method by which cooldown time for a simple system can be estimated from a dimensionless parameter read from a graph. To use the method it is necessary to know the fluid and pipe enthalpy, density, and velocity of sound in the warm gas. The idealized model and closed form solution are described, and comparison with experimental results is shown. Author

N68-19318# Technische Hochschule Munchen (West Germany). Fakultaet fuer Maschinenwesen und Elektrotechnik.
EXPERIMENTAL INVESTIGATION OF THERMAL STARTING PROCESS IN LIQUIDS OVER A HEATED HORIZONTAL PLATE [EXPERIMENTELLE UNTERSUCHUNG DES THERMISCHEN ANLAUFVORGANGS IN FLUESSIGKEITEN UEBER EINER BEHEIZTEN WAAGERECHTEN PLATTE]
Kemal Onat (Ph.D. Thesis) 25 Jul. 1967 95 p refs In GERMAN
CFSTI: HC $3.00/MF $0.65

Thermal phenomena were observed at the top surface of a horizontal plate immersed in different liquids and heated at a constant heat flux density. Plate temperature changes were measured electrically. Simultaneously, boundary layer processes were determined by means of shadowgraphs, telluric measurement, and interferometry. Three main phases were noted: (1) simple heat conductance; (2) onset of instability; and (3) unsteady and stationary convection. A formula was derived for determining the onset of convection, and the equations for stationary heat transfer were extended to higher Prandtl numbers. Transl. by K.W

N68-19351 North Carolina State Coll., Raleigh.
NONEQUILIBRIUM THERMODYNAMIC STUDY OF HEAT TRANSFER IN STATIONARY SYSTEMS WITH DIFFUSION AND CHEMICAL REACTIONS
Jerry Stevenson Lee (Ph.D. Thesis) 1967 151 p
Available from Univ. Microfilms: HC $7.20/MF $3.00 Order No 67-7423

In the first part, a transformation of the Onsager reciprocal relations is established which allows the Onsager relations among the new phenomenological coefficients, resulting from interchanging the roles of any number of independent fluxes and forces in the original phenomenological equations, to be specified immediately This transformation greatly simplifies the evaluation of the phenomenological coefficients in terms of standard transport properties. In the second part, the nonequilibrium theory is applied to an isotropic system of n reacting components with simultaneous diffusional and heat fluxes. The general phenomenological equations are established. Then they are specialized to a stationary system with all reactions in chemical equilibrium and used to define an effective heat conductivity, making the problem formally analogous to one of pure heat conduction. In contrast to the current expressions for the effective conductivity presented in the literature, the effective conductivity defined here is not restricted to perfect gas mixtures and includes contributions due to thermal diffusion. Dissert. Abstr.

N68-19445*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
IGNITION KINETICS OF THE CARBON MONOXIDE–OXYGEN REACTION

Richard S. Brokaw. Washington, 1966. 25 p, refs. Presented at the 11th Intern. Symp. on Combust., Berkeley, Calif., 14–20 Aug. 1966. Sponsored by the Combustion Inst.
(NASA-TM-X-52196) CFSTI: HC $3.00/MF $0.65 CSCL 21B

An analytic solution for the ignition kinetics of the dry $CO–O_2$ reaction is obtained by assuming an initiation reaction followed by the chain-branching steps $CO + O \rightarrow CO_2^* $ and $CO_2^* + O_2 \rightarrow CO_2 + 2O$ together with chain termination by quenching of CO_2^* and three-body recombination of CO and O. It is concluded that shock-tube induction times on reportedly dry $CO–O_2$ mixtures cannot be explained by this mechanism. The shock-tube data can be explained by the following scheme, if a water vapor content of 20 ppm or less is assumed: (1) $CO + O_2 \rightarrow CO_2 + O$ (K_1), (2) $O + H_2O \rightarrow 2OH$ (K_2), (3) $OH + CO \rightarrow CO_2 + H$ (K_3), and (4) $H + O_2 \rightarrow OH + O$ (K_4). The rate constant for the initiation reaction was found to be $k_i = 2.5 \times 10^9 \exp(-48,000/RT)$ liters $mole^{-1}$ sec^{-1}. The rate constant for the reaction between O and H_2O at 1600°K was estimated by two different methods to be 8×10^8 and 1.5×10^9 liters $mole^{-1}$ sec^{-1}. Induction periods for mixtures with deliberate additions of hydrogen can be fit by adding the steps $O + H_2 \rightarrow OH + H$ (k_3') and $OH + H_2 \rightarrow H_2O + H$ (k_4'). Author

N68-19457# Kansas State Univ., Manhattan.
BIBLIOGRAPHY OF NATURAL CONVECTION HEAT TRANSFER FROM A VERTICAL FLAT PLATE
D. V. Julian and R. G. Akins. 2 Jun. 1967. 32 p, refs. Submitted for publication.
(SR-77; PB-176581) CFSTI: HC $3.00/MF $0.65

The bibliography includes those papers published prior to January 1, 1967 that pertained to natural convection heat transfer from a vertical flat surface. This work grew out of a rather extensive literature survey in connection with an experimental study of heat transfer from a uniformly heated vertical flat plate immersed in mercury which was being done at Kansas State University. Even though natural convection is only one of many areas of heat transfer, the list of references number nearly 250. Author

N68-19465# Maryland Univ., College Park. Computer Science Center.
THE NUMERICAL SOLUTION OF THE RADIATIVE TRANSFER EQUATION
Abraham A. Tal. Nov. 1967. 20 p, refs.
(Grant E-192-67(N))
(TR-67-55; PB-176568) CFSTI: HC $3.00/MF $0.65

The report concerns the numerical solution of the integral equation y(s) = minus lambda multiplied by the integral, from 0 to mu, of the quantity x(t) d/dt (G (s,t odt + lambda G (s,mu) x (mu) minus (l-lambda) multiplied by the integral, from 0 to 1, of the quantity x (t) d/dt (G (s,t)dt + (1-lambda) G (s,l) x (l) with the side conditions x (1) = c sub 1 lambda x (mu) + (1-lambda) x (1) = c sub 2. Here, c sub 1 and c sub 2 are given constants, and G (s,t) any y (s) given functions defined on R = ((s,t) such that 0 = or < s,t = or < 1). In addition, G (s,t) satisfies 0 = or < G (s,t) = or < 1 for (s,t) epsilon R and in particular G (s,o) = 1. Author

34 GENERAL

Includes reports of a broad nature related to industrial applications and technology, and to basic research; defense aspects; law and related legal matters; and legislative hearings and documents.

N68-18292# RAND Corp., Santa Monica, Calif.
A MANAGEMENT PERSPECTIVE ON METRIC-MULTI-ECHELON TECHNIQUE FOR RECOVERABLE ITEM CONTROL
Craig C. Sherbrooke. Jan. 1968. 25 p, ref.
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5078/1-PR; AD-664324)

A shorter, informal, nontechnical version of AD-645 684, describes the mathematical model of a base-depot supply system for recoverable items of the kind that represent almost 80 percent of the Air Forces investment in spares. METRIC-generated cost-effectiveness curves should be of great help in defending budget requests. The use of more parameters, including unit cost, and a more sophisticated measure of demand prediction for low-demand items should provide better stockage decisions. The use of one standard procedure for both requirements and distribution should help in solving many of the pressing interface problems. Author (TAB)

N68-18409# RAND Corp., Santa Monica, Calif.
EFFECTS OF AN INCOME TAX ON LABOR SUPPLY
Marvin Kosters. Jan. 1968. 34 p, refs.
(P-3757; AD-664042) CFSTI: HC $3.00/MF $0.65

The discussion of the effects of an income tax on labor supply and welfare is presented in the context of highly simplified models which abstract from problems such as shifts in the distribution of income and other complications introduced by progressivity. It is intended to point out the kinds of labor supply parameters on which changes in labor supply depend when alternative tax changes are considered, and to assemble some evidence on the welfare cost of an income tax. However, the evidence on compensated wage rate effects was obtained by studying only some readily measurable dimensions of labor supply for some components of the labor force. Although the effect on the allocation of time of a relative price distortion at the labor-leisure margin appears to be very small, except perhaps as it affects the labor force behavior of married women, an income tax can also affect consumption-savings decisions as well as the allocation of labor among different types of employment. Author (TAB)

N68-18410# Technology, Inc., Dayton, Ohio.
COMPUTERIZED DATA CATALOG AND RETRIEVAL SYSTEM FOR DEPLOYABLE AERODYNAMIC DECELERATORS Final Report, 15 Dec. 1966–15 Jun. 1967
Thomas J. Hogan, Jr. and John J. Schauer. Wright-Patterson AFB, Ohio Flight Dyn. Lab. Nov. 1967. 46 p, refs.
(Contract F33615-67-C-1232)
(AFFDL-TR-67-115; AD-664046) CFSTI: HC $3.00/MF $0.65

In the development of a computerized data catalog and data retrieval system for deployable aerodynamic decelerators, the results were twofold: (1) a list of parameters which completely define the information pertinent to these decelerators; and (2) a data base (the structure to arrange the data elements making up a unit of information) and the computer program to manipulate the data base. The combination of these results constitutes a system to store and retrieve by computer techniques all data related to deployable aerodynamic decelerators. Author (TAB)

N68-18593# Joint Publications Research Service, Washington, D. C.
EVALUATING THE EFFECTIVENESS OF PARAMETERS USED WHEN CLASSIFYING OBJECTS OR PHENOMENA
Yu. V. Vagin. *In its* Tech. Cybernetics, 5 Mar. 1968, p 184–194, refs. (See N68-18577 09-19)

The problems of obtaining estimates of the effectiveness of parameters under the conditions when the classes can not be sharply distinguished from each other with respect to their properties, and the input data about the values of the observed parameters may be incomplete, are investigated. Author

N68-18629# Joint Army-Navy-Air Force Fuze Committee, Washington, D. C.
TECHNOLOGICAL FORECASTING Final Report

H. T. Darracott, J. W. Sterling, M. J. Cetron, H. A. Wells, D. B. Keckler et al 30 Jun. 1967 146 p refs
(AD-664165)

The report promotes the utilization of a system of logical analysis which, when applied to pertinent technological data, can result in credible and explicit technological conclusions. To this end, the study group attempted to evaluate, by survey and literature, possible forecasting techniques and conceptual approaches to technological forecasting. The manual is directed toward scientific or engineering specialists who may be asked to contribute inputs to forecasts but who may have only limited understanding of technological forecasting and its possible approaches and problems. It attempts to clarify a complex, controversial subject and recommends increased use of a number of techniques and a synoptic viewpoint that can improve the credibility and utility of forecasts provided by these specialists. The guide may also be of interest to users of such forecasts and, hopefully, will promote greater acceptance by providing an explanation of the rationale and methods of technological forecasting. An extensive bibliography on technological forecasting and an index is included in the report.
Author (TAB)

N68-18667*# Oklahoma State Univ., Stillwater. Coll. of Engineering.
A PILOT PROGRAM FOR SELECTING, EDITING, AND DISSEMINATING ENGINEERING AND SCIENTIFIC EDUCATIONAL SUBJECT MATTER FROM NASA TECHNICAL REPORTS Quarterly Report, 1 Dec. 1967–29 Feb. 1968
29 Feb. 1968 56 p
(Contract NSR-37-002-045)
(NASA-CR-93484; ER-68-I-2) CFSTI: HC $3.00/MF $0.65 CSCL 05B

An overview is presented on the dissemination of monographs and visual briefs based on engineering and scientific subject matter to industrial organizations and universities. This includes an advertisement in an engineering journal, letters to deans, an industrial survey, and contacts with book publishers. The various comments and responses on the visual briefs and monographs are presented along with a list of various organizations contacted.
B.S.D.

N68-18732# Indiana Univ. Foundation, Bloomington. Aerospace Research Applications Center.
EXPERIMENT TO TRANSFER TECHNOLOGY FROM A UNIVERSITY-BASED CENTER Final Report
Joseph Di Salvo Feb. 1968 37 p
(Contract NASr-162)
(NASA-CR-93482) CFSTI: HC $3.00/MF $0.65 CSCL 05B

The experimental efforts undertaken to transfer technology from a university-based information center to industrial organizations are reviewed. The successes and failures of the various transfer mechanisms used are discussed, and summary information is given on activity highlights and promotional activities. The factors influencing the ability of the center to meet the market test of generating enough income through its activity to support its operations are assessed, and problem areas are identified. To indicate that reasonable success was achieved, quantitative figures are cited on the custom retrospective searches and current-awareness searches performed, the industrial applications reports and technical reports disseminated, and the computer programs transferred. It is suggested that the answer to meeting both the objective of transferring technology and becoming self-sufficient seems to lie in expanding the user base and in the use of standardized services.
M.G.J.

N68-18733*# Indiana Univ. Foundation, Bloomington. Aerospace Research Applications Center.
STANDARD INTEREST PROFILES: DEVELOPMENT OF TECHNICAL SUBJECTS Final Report
Joseph Di Salvo and Robert W. Hall 25 Feb. 1968 95 p refs
(Contract NSR-15-003-055; Proj. 5)
(NASA-CR-93480) CFSTI: HC $3.00/MF $0.65 CSCL 05B

The chronology of Standard Interest Profiles (SIP) development is given, and an overview is presented on the approach taken to reduce the costs of current-awareness service by standardizing the product or sending the same abstracting service output to many users. The logic behind each SIP topic is defined as an effort to segment a potential market for current-awareness service to match areas in which a sufficient volume of reports are regularly released in government literature so as to make service feasible. Summary information on the technical subject area of each SIP is provided, along with a title list and index.
M.G.J.

N68-18959# Congress. House. Committee on Science and Astronautics.
APOLLO AND APOLLO APPLICATIONS
Washington GPO 1968 397 p Staff Study for Subcomm. on NASA Oversight of Comm. on Sci. and Astronautics, 90th Congr., 2d Sess., 1968

Review conferences were held at the major NASA manned space flight centers and key contractors to assess the performance, schedule, resources status, and interactions of two major NASA programs—Apollo, and Apollo Applications. Results are discussed from the viewpoint of problems and achievements, and the problems are identified which management consider are pacing or controlling the accomplishment of the program. Among the conclusions reached are: (1) Several difficult engineering problems remain to be solved in the general areas of Apollo 204 accident-related spacecraft changes, and engineering changes associated with normal development testing. (2) NASA has successfully completed flammability testing of the lunar module and appears to be in a position to accomplish similar but more difficult flammability qualification of the command module. (3) Weight growth continues to be a problem in the command and service module and lunar module, and was further complicated by changes associated with the Apollo 204 accident.
M.G.J.

N68-19345# Philco-Ford Corp., Rosslyn, Va.
THE PARAMETRIC ENVIRONMENT RELATED FUNCTIONAL ANALYSIS CODING SYSTEM
Sheldon Isaacson [1967] 24 p refs

This paper outlines the current and future scientific and technological requirements for the Parametric Environment Related Functional Analysis Code (PERFAC) system. The development of earlier parametric analytic systems, which contributed elements to the PERFAC system, is reviewed. Classification systems, relationship functions, coding schemes and evaluation techniques for the results of PERFAC are discussed. It is proposed that weighting factors, boundary values and constraints be applied by using computer processing to optimize the results of a PERFAC analysis. The PERFAC approach, which crosses fixed discipline boundaries, effectively increases the utilization of existing technological advances, and also assists the creative efforts of an individual.
Author

N68-19442# Congress. House. Committee on Science and Astronautics.
AUTHORIZING APPROPRIATIONS TO THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Washington GPO [1968] 186 p Hearing before Comm. on Sci. and Astronautics, 90th Congr., 2d Sess.
(Rept.-1181)

A bill to authorize appropriations to NASA for the fiscal year 1969 is outlined. The appropriations are for research and development, construction of facilities, and administrative operations. Each of these areas is discussed in detail. The actions, views, and recommendations of the House Committee on Science and Astronautics, to whom the bill was referred, are included.
R.N.A.

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—NATIONAL AERONAUTICS AND SPACE ACT OF 1958

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